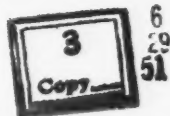


SCIENCE

APRIL 28, 1950



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*ABSTRACTS OF PAPERS PRESENTED AT
THE 1950 ANNUAL MEETING*

TECHNICAL PAPERS

COMMENTS AND COMMUNICATIONS

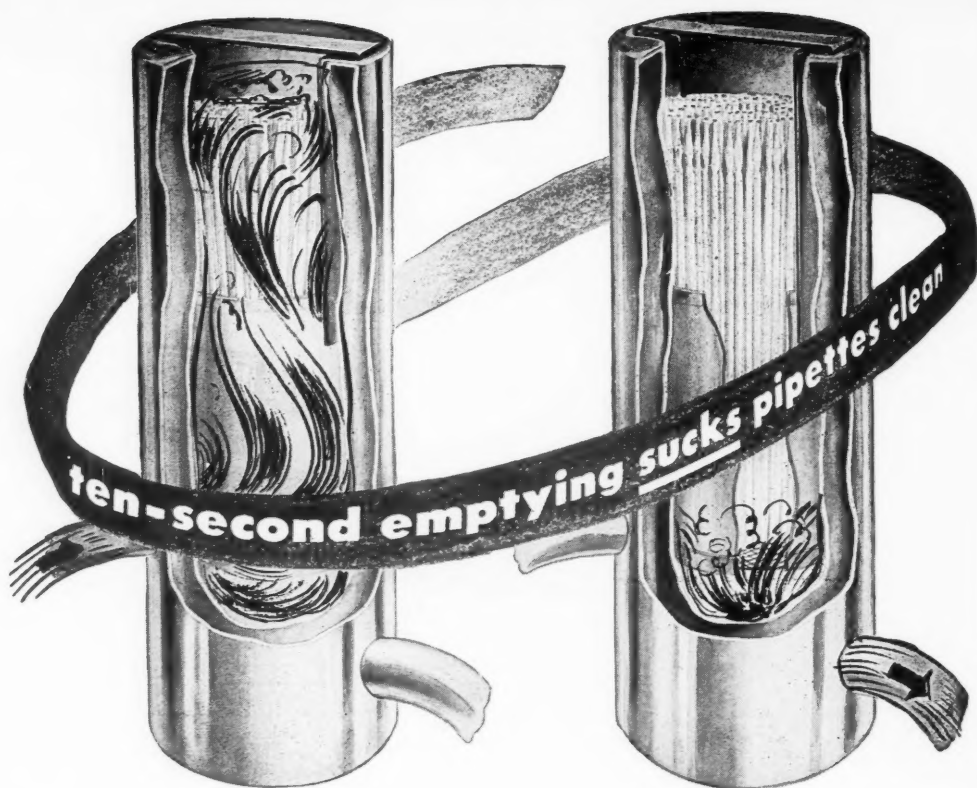
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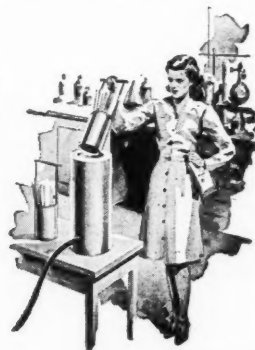
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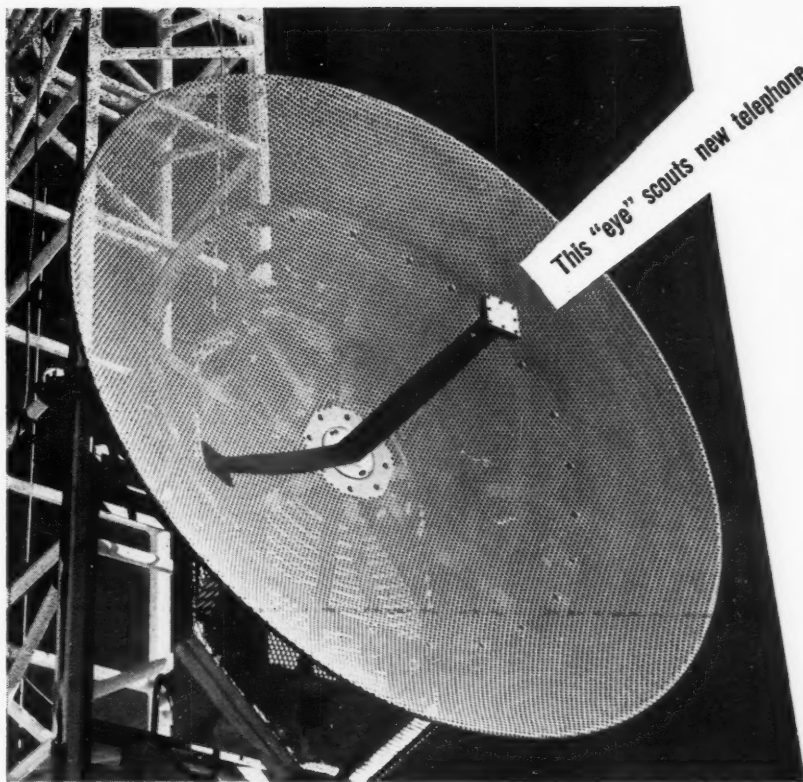
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What GENERAL ELECTRIC People Are Saying

R. S. NEBLETT

Knolls Atomic Power Laboratory

ATOMIC POWER PROBLEMS: If the atomic energy industry, particularly in the power field, is to be successful, the mechanical engineering profession has a tremendous job ahead of it. We must learn how to handle liquid metals at high temperature. We must solve the problems of heat transfer rates which at the present time seem out of this world. We not only must learn how to build these atomic power plants at an economical figure, but we must also learn how to operate them economically and how to maintain them over long periods of time. The stress analysis work, the heat transfer work, the plain mechanical ingenuity required to pump liquid metals, to say nothing of the problems of how material behaves under intense radioactivity, are all major mechanical engineering problems. Those of us in the atomic energy business feel sure that these problems will be solved, but we know that it is no easy job, and that atomic power is certainly not just around the corner.

A.S.M.E.,
Washington, D.C.,
January 26, 1950



H. M. OGLE

General Engineering & Consulting Laboratory

THE AMPLISTAT: A new static power-control device now finding many applications in industry is the amplistat. This device can be adapted to the control of most electric equipment, and it provides operation at low cost, with reduced maintenance and with long life expectancy.

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Saturable-core reactors have been used by themselves for power-control devices, although their inherent qualities of low amplification and slow response have restricted their use. The

amplistat, however, overcomes both of these limitations and definitely acquires broad usefulness as a control device.

Amplistats can be used wherever electrical signals of low or moderate frequencies are to be amplified. For some applications they are used because they have no warm-up time. In some cases they are selected because of their long life and sturdy construction, or because they are the lightest-weight equipment to do a given job. Most applications, however, are the result of a combination of these or other features, such as the ability to match impedances, or the electrical isolation of the input circuit. Amplistats, in general, are easy to apply, and they provide a flexible tool for the circuit designer.

General Electric Review,
February, 1950



J. H. SWEENEY

Electronics Department

GERMANIUM DIODES: The prices of television receivers are almost continuously being reduced, and at the same time designers are striving to reduce their weight, size, and tube complement. Today, also, engineers are designing receivers for use on the new ultra-high-frequency channels, and efficient, inexpensive converters are needed.

A major factor in the attainment of these goals is the increasing use of germanium diodes in place of vacuum tubes in many circuits. In addition to the reduction of size, weight, and number of tubes, germanium diodes also offer many other advantages. Filament hum prevalent with series-filament wiring can be eliminated; heat from filaments can be reduced; feedback can be more easily controlled; longer, reliable life can be obtained, particularly for ultra-high-frequency converters; and in many cases greater output can be obtained.

A.I.E.E.,
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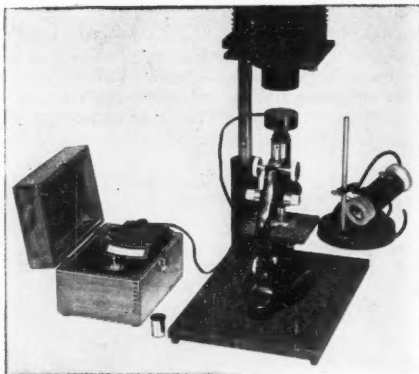
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The National Academy of Sciences

Abstracts of Papers Presented at the Annual Meeting

April 24-26, 1950, Washington, D. C.

A New Type of Self-Sterility in Plants

Ernest B. Babcock, *University of California*
and Morris B. Hughes, *Edisto Experiment Station*

Self-sterility that is caused by incompatibility between a plant's own male and female elements is a widespread phenomenon. Genetic interpretation of this phenomenon is generally based on the theory of oppositional factors. Two or more allelic factors are involved and these are termed S-alleles. According to this theory, a pollen grain is able to germinate on the stigma of the same flower from which it came, but if the S-allele carried by the pollen grain is identical with one of the two S-alleles present in the pistil, the pollen tube cannot grow down the style and fertilization is thus prevented. This is gametic determination of pollen behavior. The classical work on which this theory is based was done on a species of *Nicotiana*.

A new type of self-sterility was discovered in a species of *Crepis*. A logical interpretation of the experimental results obtained requires a very different hypothesis, including the following basic assumptions: (1) Sterility is caused by any one of a series of four S-alleles. The reaction is oppositional as in *Nicotiana*. But, because these factors differ in potency, one stronger allele may overcome the incompatibility that could otherwise have been caused by two weaker alleles. (2) No *Crepis* pollen will germinate on an incompatible stigma, regardless of whether the individual pollen grain carries a weak or a strong allele. Hence pollen behavior in *Crepis* is determined by the genotype of the plant from which the pollen came, not by the stigma on which it falls. This is sporophytic determination of pollen behavior. A genetic interpretation of the *Crepis* type of self-sterility is presented.

About Enzymatic Transphosphorylations

Otto Meyerhof and Harry Green,
University of Pennsylvania

The first type of transphosphorylation discovered was that brought about by the adenylic system, where phosphate groups of nucleotide polyphosphates, like adenosinetriphosphate (ATP), are transferred to other compounds without going through the stage of inorganic phosphate. The phosphate bond energy here can either remain the same (ATP \rightarrow phosphocreatine), or be increased (ATP \rightarrow phosphopyruvate), or be strongly decreased (ATP \rightarrow primary phosphate ester).

After Axelrod (*J. biol. Chem.*, 1948, 172, 1) had described a special type of transphosphorylation with nitrophenylphosphate mediated by acid phosphatase in the absence of adenine nucleotides, we found such transphosphorylation to be a general feature of biological phosphate esters with alkaline as well as with acid phosphatases. This transphosphorylation can be proved only by means of P^{32} because it becomes apparent in the increase of speed of synthesis of a phosphate ester in the presence of a phosphate donor; but it does not alter the final equilibrium. It was observed that this transphosphorylation occurs only from higher energy phosphate to lower energy phosphate and is the faster the greater the energy difference. Therefore, it is the greatest in the system, phosphopyruvate \rightarrow glycerol. However, the nonbiological substance nitrophenylphosphate behaves exceptionally as a P donor; with acid phosphatase, transphosphorylation is much greater than would be expected from the energy content of its phosphate group.

Spontaneous Mutations of Bacteriophage and the Mechanism of Bacteriophage Reproduction

S. E. Luria, *Indiana University*
(Introduced by T. M. Sonneborn)

Reproduction of a bacterial virus (bacteriophage) inside a bacterium is supposed to involve complex changes in virus structure. No active virus is recovered by breaking an infected bacterium open for several minutes after infection; active particles later appear and increase in number (Doermann). Mixed infection with related phages differing by two characters gives rise to recombinant phage types by a process similar to genetic recombination in sexuality (Hershey and Rotman). The proportion of recombinant individuals is the same in the final yield of phage from a bacterium and in the early, smaller yield from artificial breakage (Doermann); in both cases, the distribution of recombinants of each type from individual bacterial cells is random (Poisson distribution), indicating no clonal grouping of recombinants.

Experiments are presented showing the distribution of spontaneous "rapid lysis" mutants of phage T2 in about 3,600 bacteria. The distribution is clonal and very similar to the distribution calculated from the assumption of logarithmic (autocatalytic) reproduction of the genetic determinants involved, with a fixed probability of mutation per duplication. The mutation rate for the mutations tested (lumped) is about 1/5,000 per duplication.

The results are interpreted as proving that bacterio-

phage reproduction involves a phase of logarithmic reproduction of genetic material, followed by a terminal formation of active particles, with recombinations taking place at this terminal stage. The hypothesis of separate reproduction of genetic units, followed by their reassembly into active particles, proposed to explain phage reactivation (Luria) is shown to fit the requirements of the above interpretation.

Thermal Coagulation of Serum Albumin

Charles Huggins and Elwood V. Jensen,
University of Chicago

Depending on the pH of the medium, heat-denatured solutions of serum albumin form opaque synerizing coagula, clear nonsynerizing gels, or clots intermediate between these two types. The nature of the coagulum and the minimum albumin concentration required for gel formation have been interpreted in terms of intermolecular repulsive forces due to the net charge of the denatured albumin molecules.

In the presence of one equivalent of certain sulphhydryl reagents per mole of albumin, thermal coagulation of albumin solutions at pH 6.9 to 7.4 is markedly altered in that the least coagulable concentration is lowered, water binding is increased, and clear clots result. This effect is observed whether these substances destroy sulphhydryl groups by oxidation (iodine, hydrogen peroxide, iodosobenzoate), alkylation (iodoacetamide, chloropierin) or metallation (Ag^+ , Cd^{++}). Thus the properties of the opaque gel formed from untreated albumin in the pH range 6.9 to 7.4 depend in large degree on the presence of a free sulphhydryl group. To exert its marked effect on coagulation, the one free sulphhydryl group of serum albumin must have a unique place in the protein molecule.

Self-Duplication of Genes and Specific Interaction Between Identical Macromolecules

Herbert Jehle, *University of Nebraska*
(Introduced by H. J. Muller)

In the process of synapsis of homologous chromosomes in meiosis we encounter highly specific interactions between molecules with a specificity depending on a pair of large molecules' being identical or almost identical. Such specific interaction offers also a means of explaining self-duplication of genes in cell reproduction. The building up of a duplicate by the original gene is understandable as a bit-by-bit collection of molecules (e.g., closed peptide chains) readily available from the surrounding medium—molecules which happen to be identical with the constituent molecules of the original gene, and which are attracted near to them. Hereafter, chemical bond formation will provide for the synthesis of a complete daughter gene from the selectively attracted constituents (Muller, H. J., *Proc. roy. Soc.*, 1947, 134B, 1; *Cold Spr. Harb.*

Sympos. quant. Biol., 1941, 306ff; *Amer. Nat.*, 1922, 56, 32). In looking for an explanation of specific attraction (*op. cit.*) between identical large molecules we have to keep in mind that synapsis and, even more so, self-duplication are very general processes of unbelievable versatility, processes working for all kinds of genes so as to make even mutations accurately inheritable. The accuracy makes exact self-duplication usually unailing throughout the sequence of many chromosome generations. We investigated the quantum-mechanical behavior of a pair of rigid molecules which interact with each other by means of the vibrating electric dipole moments which accompany the molecules' thermally excited vibrations. Each one of the molecules shows, because of anharmonic resonance between commensurable modes, a statistical preference for certain phase relations between these modes (using the language of the correspondence principle). A pair of those molecules interacts strongly if it is an identical pair, because of these phase preferences.

The Follicular Phase of the Menstrual Cycle in the Rhesus Monkey

George W. Bartelmez, *University of Chicago*

The lining of the uterus (endometrium) is a target organ for ovarian hormones and when complete data are available, provides favorable material for observations on variability in endocrine responses. At the end of the follicular phase there are certain responses which appear to be adaptations for the survival and transport of spermatozoa in a presence of a ripe egg. Two such features are present to some degree in all of our 20 cases: (1) The epithelial cells are producing a thin secretion which contains glycogen and a mucin. (2) The edematous swelling of the endometrium reduces the cavity of the uterus to a narrow cleft. This is significant because of the activity of the uterine musculature at this time. The time relations within the cycle are highly variable; thus the liberation of the egg is indicated between the 7th and the 26th days of the cycle. Seven of the preovulatory and four of the immediately postovulatory endometria resemble earlier stages of the follicular phase; the others cannot be distinguished from some of the succeeding prograd phases. The differences between the groups are (1) in the shape and the amount of accumulated secretion in the glands, (2) in the form of the gland cells, and (3) in the relative number of enlarged stroma cells. The differences cannot be correlated with the time of ovulation in the cycle. Two factors seem to be involved: variations in the proportions of the available hormones and in the susceptibility of the several tissue elements.

The Factorial Description of Temperament

L. L. Thurstone, *University of Chicago*

The description of mental endowment has progressed considerably from that of a single index of general intelligence to a profile of indices, one for each of the known

primary mental abilities. The domain of personality has not been studied so intensively by multiple factor methods but several studies indicate that here also an adequate description is possible with a limited number of parameters or factors. Since dependable objective tests of personality have not yet been developed it is customary to depend on responses to a large number of questions about personality. The more stable characteristics of personality, including conative and emotional traits, are called *temperament* to distinguish them from the more changeable personality traits.

In a factorial study with 340 questions about personality it was found that seven factors account for the major part of the variance. These factors are linearly independent but they are correlated in the experimental population. These factors of temperament have been tentatively named as follows: 1) general activity, 2) impulsiveness, 3) emotional stability, 4) sociability, 5) athletic interest and strength of physical effort, 6) ascendance in the sense of dominance and leadership, and 7) reflectiveness in the sense of introspectiveness and introversion. A short schedule of 20 questions for each of these factors has been assembled for a general description of temperament. This schedule does not attempt to appraise the deeper sources of conflict and motivation.

On Gravitational Effects and Brain Development

S. W. Britton, *University of Virginia*

(Introduced by S. A. Mitchell)

Genetic and environmental factors together may be said to define the character of living things. Determinacy of form and function cannot be specifically assigned, although certain features of life appear to have been fostered by environmental agencies. Whereas solar and other radiant effects have long been recognized, the influence of gravitational attraction on organisms has been given little consideration. Not alone gross but even finer structures, including specialized orientation mechanisms, have been patterned by or in response to gravity.

Some mammals die rather quickly when exposed in the head-up position; other forms subaltern to man show marked bodily changes, and in many cases normal consciousness may not long be maintained. Carotid arterial pressure and flow are significantly reduced, and femoral venous return to the heart is greatly decreased. Even the smaller apes show these failures in compensation. Correlated are hyperglycemic and later hypoglycemic changes, and alterations in the brain wave patterns. Frequent muscular movement may aid in extending survival over several hours.

Subhuman primates normally exhibit various degrees of uprightness, but maintain such posture usually no more than one-quarter of the 24-hour day. Man alone stands erect with little or no functional disturbance; yet conversion from arboreal life took place within less than 1 percent of biological history. Contemporaneous with de-

velopment of orthograde progression, the human brain showed its greatest growth and differentiation. The force of gravity exerted linearly through the body significantly influenced conformation and growth. Delicately balanced arterial reactions, better oxygenation, and enhanced venous removal of metabolic products became possible in the head end. Special sensory and cerebral mechanisms have probably benefited particularly, through improved circulatory conditions.

The Visualization of Viruses within Infected Tissues

Ralph W. G. Wyckoff, *National Institutes of Health*

A wide variety of particles of macromolecular dimensions can now be seen under the electron microscope. Virus diseases are caused by such particles and a number of these can be visualized both in purified suspension and within the tissues they infect. This ability to see viruses carries with it the possibility of studying in very direct fashion how they are produced within the living matter that is their host.

The resolution of existing electron microscopes is sufficiently high so that there is no problem in seeing particles the size of the smallest viruses. Present difficulties in determining how virus particles are produced are of another character and arise mainly from difficulties in recognizing these particles among the great mass of macromolecular detail that is visible within both healthy and diseased cells. Series of electron micrographs are shown of cells diseased with several plant and bacterial, animal and insect viruses within which the probable infectious particles can be recognized. These photographs illustrate the nature of the problems encountered and the kind of information that can be gained through this approach to the fundamental question of the relation between a virus and its host.

Quantitative Measurements of Cerebral Blood Flow and Cerebral Oxygen Consumption in Man

Carl F. Schmidt and Seymour S. Kety,

University of Pennsylvania

It was suggested on theoretical grounds (Kety, S. S. and Schmidt, C. F. *Amer. J. Physiol.*, 1945, 143, 53) that cerebral blood flow could be measured quantitatively in man by means of the Fick Principle, i.e., by dividing the amount of a gas (such as N_2O) taken up by the brain per unit time by the amount of the same gas yielded by each unit of blood in passing through the brain at the same time. The numerator could be obtained from the N_2O content of cerebral venous blood when it had reached equality with that of arterial blood, indicating that the brain had reached saturation with N_2O at the prevailing

arterial tension. The denominator would be the integral of the cerebral arteriovenous N_2O difference during the period preceding saturation, which was usually about 10 minutes with the gas mixture used (N_2O 15%, O_2 21%, N_2 64%). The validity of this proposal was proved by calibration against direct measurements of cerebral blood flow in monkeys (*op. cit.* and Kety, S. S. *Methods in medical research*. Chicago: Year Book Publishers, 1948. Vol. 1). Given a value for cerebral blood flow, cerebral oxygen consumption could be computed from this and the prevailing cerebral arteriovenous oxygen difference. By this method studies of these functions have been made under a variety of physiological and pathological conditions. The results indicate that the human cerebral circulation is quite labile, behaving much like that of animals, e.g., exhibiting lack of strong influence by vasoconstrictor nerves. A striking parallelism between cerebral functional activity and cerebral oxygen consumption has been found in anesthesia by pentothal and ether, insulin coma, diabetic acidosis, cerebral arteriosclerosis, and brain tumor. These findings confirm in the human brain the general concept (Barcroft, J. *The respiratory function of the blood*. Cambridge, Mass.: Cambridge University Press, 1914) that the oxygen requirement of an organ runs parallel to its functional activity.

Embryonic Transplantation by the Vascular Route¹

Paul Weiss and Gert Andres, *University of Chicago*

In order (a) to study the fate of embryonic tissue cells introduced into the embryonic blood stream, and (b) to test their effects on organ development and growth, the following method was devised. A suspension of ground embryonic tissue in Tyrode solution (about 0.05 cu mm, containing about 1000 cells) is injected slowly by micropipette into a small extraembryonic vein of chick embryos of three days' incubation or older. The injected cells pass through the heart into the arterial system of the embryo, causing acute circulatory disturbance, embolisms and hemorrhages (mostly in brain and liver). Of 340 injected embryos, 222 (74 percent) survived and developed further, 23 of them beyond hatching.

In a first test of the technique, cells from a potentially pigmented breed (Barred Plymouth Rock) were injected into unpigmented hosts (pure breed White Leghorn). Donor tissues were ground 24-hour embryos or 4-day limb or wing buds. Seven of the white hosts developed dark patches of skin and feathers containing donor-type pigment. This proves that injected cells can survive in the blood stream, escape into the tissues, reach their normal sites, and multiply and differentiate there in typical fashion. Teratomas were observed in some cases.

When tissue suspensions containing presumptive pigment cells were injected directly into white embryos, the latter likewise developed colored patches in distant areas,

¹ This work was aided by the Dr. Wallace C. and Clara A. Abbott Memorial Fund of the University of Chicago and the American Cancer Society, Committee on Growth.

indicating the formation of embryonic metastases by the vascular route.

Aside from permitting controlled cell dissemination for research on growth, differentiation, and tissue affinities, the technique lends itself readily for better controlled administration of hormones, antibodies, and chemicals.

Hemolysin Production in Intact and Splenectomized Rabbits

William H. Taliaferro and Lucy G. Taliaferro, *University of Chicago*

The rise and decline of hemolysin have been followed at frequent intervals by photometric methods in rabbits following single standardized intravenous doses of sheep red cells (ranging from 2 to 250×10^7 cells). The rise and fall of antibody titers in each animal may generally be fitted to successive discontinuous semilogarithmic curves described by

$$A_t = A_0 e^{kt}$$

where A_0 and A_t are antibody titers at time zero and t , respectively; and k is the constant of increment. Comparison of intact and splenectomized rabbits indicates that the spleen ordinarily forms most of the antibody during the first phase of immunization. Splenic antibody generally accumulates in the serum rapidly with a constant value for k for several days. Thereafter, it may accumulate at a lesser rate for several more days. At the end of this period, it disappears at a rate which indicates that the half-life ranges from about 4 to 13 days, with the most convincing values in the lower range. Nonsplenic antibody sources continue to form antibody at a rate lower than the spleen and maintain serum antibody at a lower level over many months. With the largest single dose of antigen, the peak antibody titer in splenectomized animals may persist essentially unchanged for several weeks. Thus, after a single dose of antigen, the spleen apparently forms a relatively large quantity of antibody within a short period, whereas the rest of the antibody-forming sites maintain a low antibody level over a long period.

Reality Culture and Value Culture

A. L. Kroeber, *Columbia University*

Apart from social structure, language, and perhaps other constituents, two ingredients of culture first contrasted by Alfred Weber are science and technology (which he calls "civilization") as against philosophy, religion, and art (which he calls "culture"). Science and technology are human cultural activity directed toward preexistent nature, toward discovering and utilizing it. Philosophy, religion, art are only indirectly or partially slanted at nature: they are creative in themselves, and constitute rather the realm of meanings and values. I propose therefore to distinguish the two ingredients as reality culture and value culture. (The use by Weber and others of "civilization" and "culture"

is confusing because it is now customary to use "culture" to denote the sociocultural or extraorganic totality of which the two contrasting groups of activities are only part.)

The distinction is useful in that it helps define that respect (reality relation) in which culture is not only most readily transmissible and retentive but accumulative as a whole; and because it also defines those activities (with value relations) through which particular cultures are most nearly unique, that is, differentiated stylistically. However, the polarity is incomplete. Science is productively active in spurts much like the arts, manifests similar clustering of great minds, and even shows a measure of stylization according to period or area similar to that in the arts. In short, every culture is sufficiently integrated to prevent its parts or constituents from functioning as wholly independent variables.

Summation in the Auditory Sensory Process

Hallowell Davis, *Central Institute for the Deaf*

Last year we suggested that when the frequency of sound waves is high a summation of the stimulating effect of several sound waves is probably required to initiate a nerve impulse. In electrophysiological experiments on the ear of the guinea pig we have recently obtained evidence for such summation.

Our sound stimuli are very brief trains of waves at 2000, 4000, or 8000 cycles per second. The amplitude of the waves rises to a maximum during the third wave and then declines with almost equal rapidity. Such a "tone-pip" at moderate intensity sets up not more than one nerve impulse in any one nerve fiber and excites only a restricted group of nerve fibers. At 2000 c the nerve impulses are synchronized in well-defined volleys, each volley associated with a particular sound wave. At 8000 c, however, we find no such association. Also, at 8000 c near threshold, the first nerve impulses are set up by the fifth wave, two waves after the maximum amplitude of the tone-pip. This clearly indicates that there is summation of the stimulating effect of several sound waves. At 4000 c there are still clear volleys of nerve impulses associated with particular sound waves, but summation can also be demonstrated.

The ear acts like a digital machine at low frequencies and signals the time of arrival of each sound wave as far as its refractory period permits, but at high frequencies it acts like an analogue computer that integrates over several waves. The ear seems to respond to a high frequency tone-pip as a whole, and not to the individual sound waves.

Chemistry of the Adrenal Cortex

Edward C. Kendall, *Mayo Foundation*

The hormones of the adrenal cortex were separated in crystalline form and identified about fifteen years ago

through the efforts in this country of Wintersteiner and Pfaffner, and Kendall and his associates, and of Reichstein and his associates in Switzerland. The war stimulated efforts to prepare these compounds from suitable starting material which would allow their manufacture on a large scale. A method for the preparation of 11-dehydrocorticosterone (compound A) was devised in my laboratory in 1944, and in 1946 L. H. Sarett, in the research laboratory of Merck and Co., Inc., prepared compound E by a method which was not practical for large scale production. Subsequently a method was devised for the conversion of a precursor of compound A into compound E. Through a joint effort on the part of Merck and Co., Inc. and the biochemical laboratory of the Mayo Foundation a practical procedure has been evolved for the conversion of desoxycholeic acid into compound E.

In 1948, in cooperation with P. S. Hench, C. H. Slocomb, and H. F. Polley, compound E was given to patients who had rheumatoid arthritis and rheumatic fever. The results were obvious and encouraging in all patients, without exception. Compound E was then designated cortisone.

The study of cortisone in clinical medicine has now been extended to use of this hormone in a large number of other so-called nonmicrobic diseases. These have also responded favorably. These results have disclosed new concepts concerning the defense mechanism of the body.

Cortisone is the most complicated pharmaceutical product which has been prepared by synthetic methods. It is scarce and very expensive. Many attempts have been made to find other compounds more simple in chemical structure and easier to manufacture which would act vicariously for cortisone. These have been tested on patients who have rheumatoid arthritis. Not one of these compounds has produced the typical and invariable effects of cortisone.

These observations suggest that the tissues of the body are not able to convert closely related compounds into significant amounts of cortisone, and that cortisone, or 17-hydroxycorticosterone (compound F) are elaborated only in the adrenal cortex.

The Effects of Cortisone and ACTH on Rheumatic Diseases

Philip S. Hench, *Mayo Clinic*

Because patients with rheumatoid arthritis were observed to develop remissions during pregnancy or jaundice, it was concluded that this usually progressive, crippling disease was potentially reversible through the action of an "antirheumatic substance X" which might be a bisexual steroid hormone. Later it was noted that pregnancy or jaundice sometimes gave temporary relief in certain other conditions also: hay fever, migraine, psoriasis, and sensitivity to eggs. Hence it was postulated that substance X was not disease-specific, not specific merely in rheumatoid arthritis, but was group-specific. After using various procedures and substances related to jaundice or

pregnancy, generally with negative results, it was decided to study the effect of the adrenal cortical hormone, 17-hydroxy-11-dehydrocorticosterone (Kendall's compound E), later renamed cortisone.

To patients with various rheumatic and articular diseases cortisone has been given, also the pituitary adrenocorticotrophic hormone (ACTH) which stimulates responsive adrenals to produce cortisone or a cortisone-like substance such as compound F. These two hormones produced marked improvement in cases of rheumatoid arthritis, with reduction or disappearance of symptoms, objective manifestations, and biochemical abnormalities. But, with certain interesting exceptions, the improvement has been temporary; relapses have occurred quickly when use of these hormones was discontinued. Cortisone and ACTH have also suppressed the acute manifestations of rheumatic fever. Preliminary results suggest that these hormones also affect temporarily a variety of nonrheumatic conditions.

These hormones are powerful agents which affect many tissues besides the muscles and joints. Certain undesirable effects may result from prolonged or excessive administration; so far these have been reversible. But until more is known about the clinical effects and metabolism of these hormones they should be used for investigative purposes. Their value presently is to provide a means to study the mechanisms underlying onset and remission of certain diseases.

American Research on Cortisone

Chester S. Keefer, *Evans Memorial Hospital, Boston*

The Committee on the Investigation of Cortisone of the National Academy of Sciences allocated approximately 1000 grams of Cortisone to 30 investigators in 26 institutions from August to January, 1950. The objectives of the committee were to distribute an important chemical of great biological significance to qualified research workers so that information concerning its mode of action, its clinical effects, and its side effects could be obtained. This report will summarize the results that have been reported to the committee.

The Mechanism of Secretion of the Adrenal Cortical Hormones

C. N. H. Long, *Yale University School of Medicine*

The remarkable effects of cortisone and the adrenocorticotrophic hormone (ACTH) in alleviating rheumatoid arthritis, rheumatic fever, and certain allergic states have focused public attention on two hormones whose physiological properties have been the subject of a great deal of investigation during the last fifteen years. Actually, cortisone was isolated from the adrenal gland by Kendall and his colleagues in 1936 and ACTH was obtained in highly purified form from sheep pituitaries by Li, Simpson, and Evans in 1942, and from hog pituitaries by

Sayers, White, and Long in 1943. Since no other physiological property of ACTH is known besides its capacity to stimulate the secretion of cortisone or allied compounds by the adrenal cortex, it was soon recognized that the effects of the injection of ACTH would be identical with those produced by the administration of cortisone.

Furthermore, it has become evident that unless there is a prior secretion of ACTH by the anterior lobe of the pituitary, no augmentation of adrenal cortical secretion can occur. The question, therefore, as to the circumstances that are associated with an increased secretion of ACTH and the mechanism by which they cause the secretory cells of the anterior pituitary to release this hormone has become a problem of no little importance. Apart from the interest surrounding the elucidation of an important bodily function, an understanding of the mechanisms governing the secretion of the adrenal cortical hormone might well allow the development of more available agents by which the pituitary itself could be stimulated to produce sufficient ACTH, and hence of cortisone, to bring about the alleviation of certain disease states. Such an effect would obviate the necessity of administering either hormone, since all present evidence indicates that there is no insufficiency of pituitary-adrenal cortical function in individuals afflicted with arthritis or allied disorders. Rather it would appear that relief of these conditions is achieved only when amounts of ACTH or cortisone in excess of normal bodily needs is continually administered. However, since continued overdosage with either of these two potent hormones is known to be associated with the development of a number of undesirable events, the question of the feasibility of their long continued administration to man remains to be determined.

A variety of methods have been devised to determine an increased rate of secretion of the cortical hormone. Of these, only two lend themselves to the measurement of rapid changes in the secretory rate of this gland. The first of these, applicable only in experimental animals, depends on the observation that stimulation of the adrenal cortical secretion by ACTH is accompanied by a decline in the cholesterol and vitamin C content of the gland. Although it is believed that the decline in cholesterol is due to its transformation into the cortical steroids, no adequate explanation has been advanced for the association of this vitamin with the secretory mechanism. Nevertheless, either or both these chemical changes can be used as indirect indicators of increased secretion. Indeed, the depletion of ascorbic acid in the gland by ACTH is used as an assay method for the standardization of ACTH preparations for clinical use.

The second method depends on the capacity of cortisone and its allied compounds to bring about a reduction in the number of the eosinophilic cells of the blood. This method can, of course, be used in man, where a rapid reduction in the number of these cells can be taken as evidence of increased adrenal cortical secretion.

Using either of these methods, or others of lesser sensitivity, it has been shown that a wide variety of circumstances acting within or without the body bring about increased ACTH secretion and hence that of the adrenal

cortex. So different are these circumstances, including as they do changes in environmental temperature, pain, trauma, infections, and even strong emotional states, that the question arises as to what may be their common denominator in producing activation of the anterior lobe of the pituitary.

Two explanations have been advanced. The first was suggested by the work of Ingle, Higgins, and Kendall and has been expanded recently by Sayers. The latter concludes that all these various circumstances increase the tissue utilization of cortical hormone, thus lowering its level in the blood. In consequence, the anterior pituitary responds by secreting additional ACTH in an attempt to restore the original blood level of the cortical hormone and thus ensure an adequate supply for the needs of the emergency.

The second suggested mechanism rests on the observation that the majority of the circumstances associated with an increased cortical secretion are also those that provoke an increased degree of activity of the autonomic nervous system with a concomitant increased secretion of epinephrine. In support of this view it has been shown that the injection of epinephrine in physiological amounts is capable of stimulating ACTH secretion.

The experimental evidence supporting both these hypotheses will be presented. It leads to the present conclusion that both types of activation of ACTH secretion are available to meet an increased demand for cortical hormone. The ability of epinephrine to activate the anterior pituitary must now be added to the previously known functions of this hormone. As was pointed out by the late W. B. Cannon, the physiological responses induced by epinephrine are of a kind that enable the organism to adapt itself to emergencies. The participation of the anterior pituitary and adrenal cortex in this response is particularly necessary by reason of the increased requirement for their hormones that such emergency states appear to demand.

The Chemical Combination of Insulin with Muscle and Its Hormonal Regulation

William C. Stadie

Maloney Clinic, University of Pennsylvania

The complete understanding of the problems associated with diabetes is largely dependent upon a greater knowledge than is now available of the chemical or physical mechanisms by which insulin affects the metabolism of mammalian tissue.

Effects of insulin upon metabolic reactions in intact cells, either *in vitro* or *in vivo*, have been unequivocally demonstrated by many workers. This is in sharp contrast to the difficulty in demonstrating unequivocal effects upon cell-free enzyme systems. Irrespective of the precise mode of action of insulin, it is conceivable that once having entered the cell, insulin might attach itself to some morphological element. This initial direct combination of insulin with the intact cell might indeed be the initial obligatory reaction required for the further

metabolic activity of the hormone. We (Stadie, W. C. *et al. Amer. J. med. Sci.*, Sept. 1949) have succeeded in demonstrating that such chemical reaction occurs.

The demonstration was accomplished in the following way: A hemidiaphragm from a normal rat is equilibrated for one minute or less in a medium containing a small concentration of insulin. During this brief exposure to insulin, firm combination has occurred with some constituent of the muscle cell, and the combined insulin alters the metabolic pattern of the muscle. This is shown by the fact that invariably the insulinized hemidiaphragm, when equilibrated in a glucose-containing medium (with no added insulin), utilizes more glucose and synthesizes more glycogen than an appropriate non-insulinized control.

This phenomenon has been studied in the normal rat under a variety of conditions, and in rats with endocrine abnormalities, or those injected with various hormonal preparations. The results indicate that the chemical combination of insulin with muscle is under hormonal control. It is concluded that this phenomenon plays an important role in the regulatory mechanism of carbohydrate metabolism in the normal and diabetic animal.

Sickle Cell Anemia Hemoglobin

Linus Pauling, Harvey A. Itano, Ibert C. Wells, Walter A. Schroeder, Lois M. Kay, S. J. Singer, and R. B. Corey, California Institute of Technology

Amino acid analyses of hydrolyzates of normal human adult hemoglobin and sickle cell anemia hemoglobin have shown that there is no difference in the number of residues of the acidic and basic amino acids in these molecules. There may be small differences in the number of residues of leucine, serine, valine, and threonine. Preparations of hemin chloride and the dimethyl ester of the heme porphyrin from the two hemoglobins have been found to be identical. The globin preparations resulting from acid acetone treatment of the two hemoglobins give the same electrophoretic patterns. The difference of 0.23 pH units in the isoelectric point of the hemoglobins cannot be attributed to difference in the number of acidic or basic amino acid residues, but is presumably the result of a change in ionization constants of acidic and basic groups resulting from a difference in folding of the polypeptide chain.

The amount of sickle cell anemia hemoglobin in the erythrocytes of 25 individuals having the sickle cell trait has been determined, and values within the range 25 percent to 44 percent have been observed.

Photosynthetic Efficiency of the Tomato Plant as Influenced by Light Intensity and Temperature

F. W. Went, California Institute of Technology

In the new Earhart Plant Research Laboratory of the California Institute of Technology plants can be grown under conditions of completely controlled light, tempera-

ture, humidity, and rate of air movement. Tomato plants, grown under artificial light of 2,000 foot-candle intensity, developed normally and were quite as heavy as plants grown in full sunlight for the same length of time and the same photoperiod. Their fruiting however, amounted to only about 25 percent of the fruit production in daylight.

It was found that for plants all grown in exactly the same light intensity, temperatures of 20°–23° C, coupled with nyctotemperatures of 10°–20° C, gave the greatest dry matter production. On the assumption that the dry matter exclusive of ash of a tomato plant has a caloric value of 3,700 calories per gram, and that one foot-candle equals 16 ergs/cm²/sec, it was found that under optimal temperature treatments over a growing period of 2½ months, 17 percent of the light energy which reached the tomato plants was transformed into chemical energy.

Dry matter production turned out to be a good measure of photosynthetic efficiency. Values can be obtained over much shorter growing intervals, provided the plant material is uniform. This can be achieved to a sufficient degree with young tomato plants, and they showed photosynthetic efficiencies of 16 percent to 18 percent at 1,000 ft-c and of 10 percent to 12 percent at 2,000 ft-c. These values are all obtained under arbitrary spectral composition of the light, and might be higher for optimal distribution of wavelengths. Even without corrections for respiration and reflected and transmitted light, efficiencies can be calculated which ten times surpass the efficiency of field-grown plants. This provides a basis for expecting higher crop yields per acre if conditions are created to make full use of the potential photosynthetic efficiency of plants.

The Trisection of Horn Angles

Edward Kasner, *Columbia University*

A horn angle is formed by two curves *A* and *B*, touching at the vertex *V*. Such an angle is bisected by a curve *C* if the image of *A* in *C* is *B*. Trisection is defined by successive symmetry (all constructions are invariant under conformal transformation).

If the curves *A* and *B* are circles, the bisector and the two trisectors are also circles; and the constructions can be effected with the traditional ruler and compass.

The general measure of a horn angle is an invariant of third order, but for circles second order terms are sufficient.

The Intermediate Nucleus and the Hydrogen Bomb

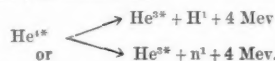
William D. Harkins, *University of Chicago*

Two relations discovered by Harkins and Wilson and by Harkins in 1915 and 1926 are related to the efficiency of an atomic bomb. According to the former, one pound of hydrogen by a loss of mass in conversion into helium gives as much energy as the combustion of ten thousand tons of coal. This heats the sun and the stars.

The 1926 paper considered that all nuclear reactions give an intermediate-compound nucleus. All atomic bombs owe their explosive characteristics to the exceedingly short life of this intermediate nucleus. In the uranium bomb, U²³⁵ is formed by the action of a slow neutron on U²³⁸. In a hydrogen bomb containing tritium the percentage loss of mass would be relatively high, since the exceedingly stable nucleus He⁴ is produced. The reaction would be



However, tritium is too costly. Ordinary hydrogen would give the greatest energy if it could be converted completely into helium of mass 4, but presumably this requires a series of reactions, and is too slow. Deuterium, which is hydrogen of mass 2, will be employed according to the following reaction:



although the energy is only about one-third of that given by tritium. Lithium deuteride or tritide would reduce the volume employed.

Structural Chemistry of the 5f Elements

W. H. Zachariasen, *University of Chicago*

The crystal structures of some two hundred compounds of the elements from actinium (atomic No. 89) to americium (atomic No. 95) have been investigated. The results of these systematic studies have led to a satisfactory understanding of the structural chemistry of these elements and of the relationship to similar groups of elements in the periodic system.

In the solid state the following bona fide valencies are exhibited by the elements under consideration:

Ac	Th	Pa	U	Np	Pu	Am
3			3	3	3	3
	4	4	4	4	4	4
		5	5			
			6	6	6	

The crystal structure results show that for a given valence state the atomic or ionic radius slowly decreases with increasing atomic number. Thus the tetravalent ionic radius decreases from 0.98 Å at thorium to 0.88 Å at americium.

This contraction in atomic dimensions is due to electrons entering the 5f shell. A similar contraction in size was found by V. M. Goldschmidt for the 4f elements.

That a 5f series of elements might begin near the end of the periodic system was long suspected. Indeed, the suggestion was first made by Niels Bohr thirty years ago.

The trivalent state is the important one for the 4f elements, although some 4f elements may exhibit divalent or tetravalent states as well. In contrast the triva-

lent, tetravalent, and hexavalent states are of comparable importance for the 5f elements.

The various 5f elements are closely related as regards their structural chemistry. Analogous compounds have as a general rule analogous structures. A 5f element is only slightly larger than the corresponding 4f element. As a consequence one observes a close crystal chemical relationship between 4f and 5f elements in the trivalent and the tetravalent states.

The Compressibility of Metals

Linus Pauling, *California Institute of Technology*

It has been found that an expression for the dependence of the volume of a metal or similar substance with atoms held together by covalent bonds on the pressure can be derived by assuming that each atom interacts with its neighbors in the way corresponding to a Morse potential function. Bridgman's high pressure data for many substances can be accounted for satisfactorily in this way.

The Limiting Negative Pressure of Water Between 0° and 50° C

Lyman J. Briggs, *National Bureau of Standards*

A further study has been made of the limiting negative pressure of water, at temperatures ranging from 0° to 50° C, by the method described at the 1949 Washington meeting of the Academy. (*Science*, 1949, 109, 440.)

The limiting negative pressure of water is found to be profoundly influenced by temperature. The negative pressure reaches its maximum value of 277 bars between 8° and 10° C. It drops to 263 bars at 25° C and 215 bars at 50° C. But it is in the region between 5° and 0° that the effect of temperature is most striking. Below 5° the limiting negative pressure drops sharply and progressively, until near 0° it is less than 10 percent of its maximum value.

The experimental results cannot be explained by changes in density. The total change in the density of water in heating from 0° to 5° C is only 0.00013. At 25° an equal change in density is produced by changing the temperature 0.5°. In the first temperature interval a 10-fold change in the limiting negative pressure takes place; in the second, the change is only 0.4 percent.

The observed results may be accounted for as follows: When water is cooled to 4° C, aggregates of molecules begin to form; they grow in size as the temperature is progressively lowered; they are irregular in shape and do not pack as closely as single molecules, as shown by the observed decrease in density; consequently, voids must exist between the aggregates; as the molecular aggregates increase in size, so do the voids; the water column ruptures when a given void cannot withstand the applied negative pressure.

Eddy Current Damping of a Superconductor

W. V. Houston and Nils Muench, *The Rice Institute*

To investigate the electromagnetic ponderomotive force on a superconductor, a tin sphere was suspended from a torsion fiber in a horizontal magnetic field. Above the transition temperature the damping constant was proportional to the conductivity. Below the transition temperature it dropped to less than one part in 10⁶ of its value at 4.2° K.

According to the usual theory of eddy current damping, the damping constant should be proportional to the conductivity for conductivities in the usual range. A sufficiently high conductivity, however, will lead to a vanishing damping force, but will be accompanied by a large restoring force. No change in period of the necessary magnitude was observed.

According to the London theory, the supercurrents exert no force in the body of the superconductor and should produce no damping or change in period under these experimental conditions. However, small ordinary currents may also be expected which should lead to some damping and change in period. The accuracy of the measurements was insufficient to detect such effects and the results are in conformity with the London prediction.

Electrical Ponderomotive Forces within Material Bodies

J. Slepian, *Westinghouse Electric Corporation*

In classical electromagnetism the electrical force acting on a charged probe or small body is operationally defined as that force which must be added to the assumedly completely observable mechanical forces to restore otherwise failing classical particle mechanics. For a large body, rigid or nonrigid, lying in empty space, we may also define a total electromagnetic ponderomotive force as that force which added to the presumably observable total mechanical force restores otherwise failing mechanics. For such a body, the total electromagnetic force thus operationally defined may be undetermined by applying Maxwell's stress tensor in the empty space surrounding the body.

Very generally it is believed that specifically electromagnetic ponderomotive forces, volume and surface, exist within material bodies. Presumably these electromagnetic forces are to be defined by balancing properly with the mechanical stress tensor within the body.

One may attempt to define this mechanical stress tensor through the mechanical force required to keep the strain unchanged on making a cut along an element of surface within the body. However, in an electromagnetic field the force so obtained is not derivable from a tensor.

We may define as a possible electromagnetic stress tensor any tensor whose components are functions of the field vectors, E , D , H , and B , and the charge and current densities σ and i , and which in empty space, i.e.,

where $E = D$, $H = B$, $\sigma = 0$, and $i = 0$ reduces to Maxwell's electromagnetic stress tensor. Then we define the associated mechanical stress tensor through the vector difference between the calculated electrical surface force for the sides of the cut, and the mechanical force observed there, this difference being derivable from a tensor.

These two largely arbitrary tensors meet all the requirements of mechanics and electromagnetism and no experiment can distinguish between the validities of the various sets of such possible tensors. There is then no physically significant uniquely definable volume and surface electromagnetic ponderomotive force within a material body.

Rancho Santa Fe Conference concerning the Evolution of the Earth

Louis B. Slichter, *University of California
Institute of Geophysics, Los Angeles*

Under the joint auspices of the National Academy of Sciences, the University of California, and the California Institute of Technology, a round table discussion concerning the evolution of the earth was held at Rancho Santa Fe, California, on January 23, 24, and 25, 1950. The conference was attended by 24 scientists representing the subjects of astronomy, chemistry, geochemistry, geology, fluid dynamics, physics, geophysics, and oceanography. The discussion was informal, no prepared papers being presented. The stimulating ideas of Dr. Urey presented at the November, 1949, meeting of the National Academy were a central theme, and discussion covered many aspects of the problem of the earth's evolution. The following topics were among those discussed:

1. Theories of the origin of the earth from materials of moderate temperatures, to form an earth nonmolten at the outset.
2. Consideration of the spacing of the planets in the solar system ("Bode's Law") in terms of a statistical "mixing length" in the fluid mechanics of turbulence. The implications of the apparent differences and similarities in the earth and its neighboring planets and in their atmospheres; the composition of cosmic materials and of the earth.
3. The nature of the chemical environment during the earth's origin which is required by or is consistent with present postulates concerning the internal composition of the earth, and with present knowledge of its atmosphere and oceans.
4. The available sources of geological energy and their adequacy to perform the work of continent- and mountain-building. The fractionation of the original crustal material of composition of stony meteorites into dunite and basalt may provide an adequate mechanism for the continued growth of continents. Recent summaries of the age relations of the major pre-Cambrian orogenies in North America appear to furnish signifi-

cant indications of the history of the growth of this continent.

5. Evidence for the continued growth of oceans was presented.

6. A method for estimating the compressibility and density of materials under pressures as high as those occurring in the central parts of the earth was reported.

The Thermoluminescence of Rocks

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Many rocks when heated emit light due to the release of electrons which have been driven into traps by radiation from traces of radioactivity over geological periods of time. Most fluorites, limestones, and potassium feldspars exhibit this phenomenon.

Of 1500 samples of common rocks examined, over three-quarters showed visible thermoluminescence.

Automatically recorded curves were obtained giving the intensity of light as a function of time while the rock samples were heated at a rate of about 50° C per minute. The intensity peaks in the curves are characteristic of the minerals present in the rock, the radioactivity content, the impurities in the minerals, and the geological history of the rock.

Thermoluminescence has been produced in minerals and pure crystals by exposure to radioactive cobalt produced in the Nuclear Reactor at Argonne National Laboratory. The gamma-induced thermoluminescence curves have been compared with the natural thermoluminescence curves in attempting to interpret the geological history of the samples.

The pattern of thermoluminescence as photographed can be correlated with the patterns of radioactivity as obtained by exposure to nuclear track photographic plates and, hence, shows the distribution of radioactive minerals in granites.

The shape of the gamma-induced thermoluminescence curves from limestones can be used as a tool for ascertaining if samples from different localities are from the same rock stratum.

The study of mineral crystals which have been adjacent to radioactive minerals in nature makes possible the determination of radiation damage produced by very long exposure to radioactivity.

Paleotemperatures of the Upper Cretaceous

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The relative abundance of the oxygen isotopes in calcium carbonate differs from that of the water from which it is deposited and varies with the temperature of deposition. These physical facts make possible the use of the relative abundances for the measurement of temperature. Such a thermometer is difficult to use, but

it may have great durability and hence make possible the measurement of temperatures in past geological ages. In order that this thermometer shall be effective, it is necessary that living organisms lay down their shells in equilibrium with the sea, that the effects shall be preserved with time, that the oceans shall have a constant isotopic composition, and that a mass spectrometer of sufficient precision and reliability be constructed.

We have found that all these various difficulties can be overcome, though there is considerable error due to geographical variation of the isotopic composition of

sea water in the present oceans and presumably this may have existed in the past. Using such a thermometer we have found that the temperatures of the Upper Cretaceous seas of the southeastern United States, England, and Denmark were remarkably constant at about 16° C. The organism used for most of this work has been *Belemnitella americana*, which has a particularly compact structure. The uniformity of this temperature may be due to the better circulation of water in the Upper Cretaceous seas, though the possibility of error due to variation in isotopic composition cannot be excluded.

Technical Papers

The Availability of Various Manganese Oxides to Plants

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Manganese deficiency of cereals is normally confined to soils of pH higher than 6.5, and to relatively few types in this range. The majority of neutral and alkaline soils can provide plants with ample manganese and most of these "healthy" soils contain large amounts of manganese (100 ppm or more) present as oxides which are insoluble in water but easily reducible (5). Such oxides

We have compared several oxides, both natural and synthetic, for their ability to supply manganese to oats when mixed with soils on which oats had previously failed through manganese deficiency. The added manganese in all cases amounted to 90 ppm of the soils as a uniform mixture. The plants were grown in the open in glazed pots. As the figures show (Table 1), the effects ranged from zero to complete cure.

Only oxides prepared in the wet way were successful. Electron microscopy showed that all oxides prepared in the wet way had large specific surface. This in its turn implies a large area of contact of root with oxide, which seems to be needed for success. But failure of hausmannite shows that structural type is also important.

The oxides were also compared in the laboratory for their rate of releasing manganese to a weakly reducing

TABLE 1

X-ray structure	Preparation	Value of n in MnO_n	Response of Algerian oats	
			Rendelsham soil§	Yambuk soil
Manganous manganite	W* (3)	1.99	Cure	Cure
Pyrolusite 1	W (1)	1.97	Cure	Partial Cure
Pyrolusite 2	D† (1)	2.00	Nil	Nil
Manganite	W (4)	1.52	Cure	Cure
Hausmannite 1 ..	W (4)	1.35	Nil	Nil
Hausmannite 2 ..	D‡	1.35	Nil	Nil
Cryptomelane and γ - MnO_2 ...	Ore	...	Nil	Nil

* W: Prepared in the wet way.

† D: Prepared in the dry way.

‡ Heat treatment of hausmannite prepared in the wet way.

§ The Rendelsham soil is a grey calcareous peat of pH 7.9 from South Australia.

|| The Yambuk soil is a grey calcareous peat of pH 8.0 from Victoria.

may comprise many structural types of different degrees of oxidation, although they are conventionally referred to as manganese dioxide.

TABLE 2

X-ray structure	Response of oats (see Table 1)	Ammonium acetate-quinol	Water-quinol
		%*	%*
Manganous manganite ..	+	94	57
Pyrolusite 1	+	100	33
Pyrolusite 2	-	87	14
Manganite	+	100	35
Hausmannite 1	-	91	8
Hausmannite 2	-	6	7
Cryptomelane and γ - MnO_2	-	78	14

* Manganese extracted, expressed as percentage of total amount from 10 mg oxide with 0.05% quinol solutions at pH 7. One hour contact.

solution. A solution of quinol in normal ammonium acetate as used earlier for soils (5; see also 2, p. 20) failed different result (Table 2), giving a good correlation with pot tests.

The last experiment suggests that the combined effect of a reducing agent and a concentrated electrolyte is too drastic. Quinol alone, or in the presence of a dilute electrolyte, removes only those manganous ions that are

loosely held by the crystal lattice after reduction. In the presence of concentrated ammonium ion, on the other hand, the manganous ions continuously leave the surface of the oxide, exposing a fresh surface to attack by the quinol. This argument in its turn suggests that in estimating the manganese in soil that is available to plants the reducing agent should be removed before an extraction with electrolyte. Preliminary work along these lines has given results that are correlated with the health of oats, as observed in pot tests. The earlier method of extracting with ammonium acetate accompanying quinol has failed to distinguish some of these soils.

The "cure" referred to in these tables was obtained in the first year after application. Some oxides revert in some soils to a less active form in later years; the results of work on the conditions of this reversion are being prepared for publication elsewhere.

References

1. COLE, W. F., WADSLEY, A. D., and WALKLEY, A. *Trans. electrochem. Soc.*, 1947, **92**, 133.
2. DION, H. G., MANN, P. J. G., and HEINTZE, S. G. *J. agric. Sci.*, 1947, **37**, 17.
3. DUBOIS, P. *Ann. Chimie*, 1936, **5**, 411.
4. FEITKNECHT, W. and MARTI, W. *Helv. Chim. Acta*, 1945, **28**, 129 and 149.
5. LEEPER, G. W. *Soil Sci.*, 1947, **63**, 79.

The Distribution of S^{34} in Nature and the Sulfur Cycle¹

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Relatively large variations in the abundances of the sulfur isotopes in natural sources have been reported from this laboratory (1, 2). Also, A. Trafimov (3) reported some indication of these variations. In our work, sulfates in general were found to be enriched in the heavy isotopes of sulfur as compared to hydrogen sulfide and other sources of sulfur (see Fig. 1). The results suggested that sea water sulfate, the source of many sulfate deposits, would also be enriched and that the large reservoir of sulfur in the sea might provide a base level from which the isotopic content of other sulfur sources might be reckoned. The results of four sea water sulfate samples investigated to date are given in Table 1. From Fig. 1 it can be seen that the sea water sulfates are enriched in these heavy isotopes in comparison to other sources of sulfur and that the isotopic ratios obtained are remarkably constant for the three different oceans. The high precision abundance data does show, however, some significant difference between Pacific and Atlantic.

Previous results reported from this laboratory showed that sulfate and hydrogen sulfide present together in

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² Holder of a Research Council of Ontario Scholarship.

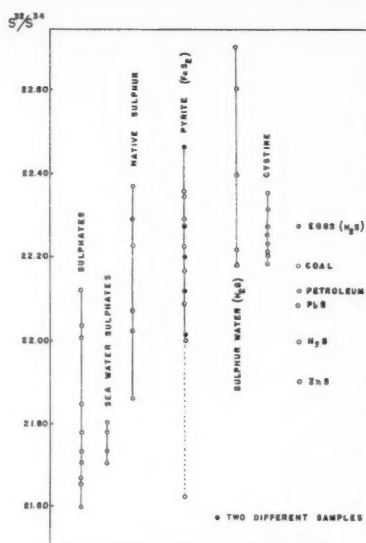


FIG. 1. Distribution of S^{34} in nature.

ground water samples, contained markedly different isotopic abundances. The sulfate samples were in every case enriched in S^{34} as compared to H_2S . This result and the fact that sea water sulfate samples are also enriched by about the same factor suggest isotope fractionation in the conversion of sulfate to hydrogen sulfide in nature.

The partition function ratios for isotopic substances involving sulfur have been calculated by the well-known methods of statistical mechanics. For example:

$$\frac{QS^{34}O_4}{QS^{32}O_4} \text{ and } \frac{QH_2S^{34}}{QH_2S^{32}}$$

turn out to be 1.088 and 1.015 respectively where Q is the partition function of the isotopic molecule in question. These calculations indicate that in the conversion of SO_4 to H_2S , perhaps by action of sulfur bacteria, the isotopes of sulfur will be fractionated, favoring S^{34} and S^{33} in the sulfate ion by a factor of the

TABLE 1
ISOTOPIC CONSTITUTION OF SULFUR FROM SULFATE IN SEA WATER

Sample No.	Location	180° Mass spectrometer* S^{34}/S^{32} ratio
1	Halifax Harbor (Atlantic Ocean)	21.70 ± 0.02
2	Resolute Bay Cornwallis Island (Arctic Ocean)	21.73 ± 0.02
3	Straits of Juan de Fuca Victoria, B.C. (Pacific Ocean)	21.78 ± 0.02
4	Pacific Naval Laboratory #27 Depth 200 yd	21.80 ± 0.01
Average		21.75 ± 0.02

* Each sample is ratioed to Park City, Utah, having S^{34}/S^{32} equal to 22.12.

same order of magnitude as that indicated by our results. If sulfate is converted to hydrogen sulfide under equilibrium conditions, then the calculated enrichment factor for S^{34} would be $1.088/1.015 = 1.072$. However, if it is a unidirectional process, then the enrichment factor will depend largely on the 1.088 factor above.

Controlled laboratory experiments are being carried out in collaboration with H. Kleerekoper of our Zoology Department to determine the extent of sulfur isotope fractionation that occurs when anaerobic sulfur bacteria attack and reduce sulfate to hydrogen sulfide. This process occurs at the bottom of the sea and in swamps under anaerobic conditions and is part of the natural sulfur

TABLE 2
ISOTOPIC CONSTITUTION OF SULPHUR FROM CYSTINE

Sample No.	Source	180° Mass spectrometer* S^{32}/S^{34} ratio
1	Commercial cystine (Eastman Kodak)	22.32 ± 0.01
2	Human hair†	22.35 ± 0.01
3	"	22.27 ± 0.01
4	"	22.18 ± 0.02
5	"	22.21 ± 0.01
6	"	22.20 ± 0.01
7	"	22.23 ± 0.01
	Average	22.25 ± 0.02
8	H ₂ S from eggs	22.27 ± 0.02

* Each sample ratioed to pyrite from Park City, Utah, having an S^{32}/S^{34} ratio equal to 22.12.

† Each sample of hair was taken from a different individual.

cycle. On the other hand, certain aerobic sulfur bacteria act on organic matter and H₂S to produce free sulfur and sulfate. Sulfur isotope fractionation may occur in these processes as well. It is known from our previous results that free sulfur from the Gulf of Mexico, which is considered to be of bacterial origin, is low in S^{34} as compared to free sulfur from Italy and Sicily, which are of volcanic origin. These bacterial processes are being investigated in this laboratory also.

Sulfur samples from cystine, obtained from human hair, have also been investigated. The S^{32}/S^{34} ratios obtained are given in Table 2. Fig. 1 shows that these isotopic ratios for organic material, and for cystine in particular, fall between the values obtained for sulfates and hydrogen sulfides, although for the most part the organic sulfur is low in S^{34} content.

Since amino acid and protein sulfur are synthesized by plants which utilize sulfates in the soil (a part of the sulfur cycle), it is possible that some fractionation of the sulfur isotopes occurs in photosynthesis. Experiments are in progress using *Chlorella* to investigate this possibility.

References

1. THODE, H. G. Paper presented at the Roy Soc. Canad. meeting, Vancouver, B.C., June 1948.
2. THODE, H. G., MACNAMARA, J., and COLLINS, C. B. *Canad. J. Res.*, 1949, **B27**, 361.
3. TRAPIMOV, A. *Doklady Akad. Nauk. U. S. S. R.*, 1949, **66**, 181.

Weight and Body Temperature¹

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Although it is generally stated that the normal body temperature of birds is higher than that of mammals, examination of the literature shows the temperature of some birds to be as low as 39°C (10), whereas many mammals have temperatures as high as 39.5°C (3). An analysis of available data (2, 3, 10-12) shows that the

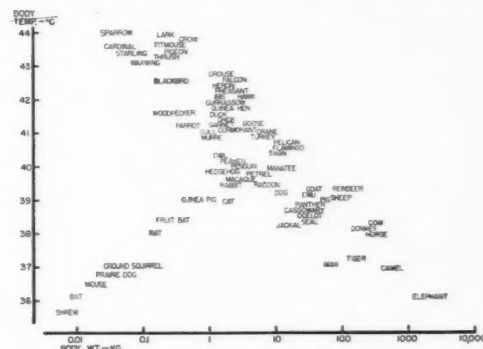


FIG. 1.

body temperature of large birds is approximately of the same order as that of mammals of the same size.

A plot of the body temperatures of birds against the logarithm of the average weight of the adult of the species gives a linear relationship (Fig. 1). Birds of 1 kg have a body temperature of about 41.5°C . For each tenfold decrease in weight, the body temperature increases about 1.5°C . A similar plot of data on large mammals gives approximately the same slope with perhaps a slightly lower intercept. However, for the small mammals weighing less than 1 kg, a line of different slope is obtained. In these, each tenfold decrease in weight is accompanied by a decrease in body temperature of about 1.5°C .

Since body temperature varies somewhat with the diurnal and reproductive cycles, age, exercise, excitement, depth of insertion of the thermometer, and environmental temperatures, the plotted data are considered as so many areas having a range of $\pm 0.5^\circ\text{C}$, rather than as points. The weight of mature animals of a species also varies within a range, as indicated. Because of the extreme variability of data on the body temperature of mammals with poor temperature regulation, such as monotremes and edentates, these are not included in the present analysis.

In small animals, the small amount of metabolizing

¹ Aided in part by a contract from the Department of the Army to the Michael Reese Hospital.

² The Department is supported in part by the Michael Reese Research Foundation.

mass compared to surface area available for heat loss results in a precarious juggling between the production of heat and its dissipation to the environment. This is manifested in the wide diurnal variations in body temperature seen in the small birds. In the small mammals, with a less efficient insulation, a body temperature as high as that of the small birds apparently cannot be maintained. This is evidenced in the hypothermic response of small rodents to infection or to the injection of foreign proteins (6), which in larger animals leads to a febrile response. This poorly developed homeothermism is also seen in the facility with which the body temperature of small mammals falls and a state of hibernation ensues on exposure to cold. By contrast, animals such as the bear with a large ratio of mass to surface area have only a slight fall in body temperature on entering the hibernating state (1).

A number of physiological measurements such as heart rate, cardiac output, and oxygen consumption have been correlated with weight (4). However, body temperature also play a significant role in the determination of these functions. This is illustrated by the fact that the mouse has a heart rate of about 670, while the canary, also weighing about 20 g, has a heart rate of 1000 per min. The mouse has a normal body temperature of about 37° C, while the body temperature of the canary is about 44° C. We have recently shown that in some species, the blood pressure and the level of the blood sugar are related to the body temperature (7-9). The blood pressures and blood sugars of birds are generally higher than those for mammals, in accord with their higher body temperatures. That these effects are related to body temperature rather than to weight is shown by the fact that small mammals (4) have much lower blood pressures than do birds of the same weight (13).

Studies on the metabolic rates of animals have been based on a calculated surface area based upon approximately the 0.7 power of the weight (5). However, since weight of the animal appears to affect the body temperature, which in itself plays a significant role in the metabolic rate of the animal, simple conversion of weight to surface area may lead to considerable error. This is apparent upon consideration of the fact that a variation of only 1° C in body temperature may increase the resting metabolism by 10%. It would therefore appear that comparisons of the metabolic activity of various species on the basis of surface area alone, without regard to weight and body temperature, are likely to be misleading.

Individuals of a given species may all have approximately the same body temperature, despite fairly large variations in body size. Adequate data on this point are not available. The weight-body temperature relationship may, however, appear in the fact that young animals have slightly higher body temperature than adults of the same species.

It is noteworthy that closely related species may have fairly deviant body temperatures in accordance with their body weights. Since the setting of the normal body temperature determines the lethal level in fever, a bird of

large size with a normal temperature of 40° C will have lethal body temperature of about 44° C, while a very small but closely related species with a normal temperature of 44° C may have a lethal temperature of 47° C. This difference in lethal thermal levels suggests that the mechanisms leading to death in pyrexia devolve upon disturbances in specific physiological adjustments induced by change in body temperatures, rather than upon the absolute temperature level itself.

The fact that various unrelated species of large size have body temperatures in the same range indicates the independent achievement of these thermal levels. This may be dependent upon survival factors related to the size of animal. It suggests that for large homeotherms of a given weight, a particular level of body temperature is optimal for survival. In small homeotherms, other factors predominate, resulting in a marked disparity between the body temperatures of birds and mammals of the same size.

References

1. BENEDICT, F. G. and LEE, R. C. *Carnegie Instn. Publ.* #497, 1938.
2. BERNARD, R., CAYOUCETTE, R., and BRASSARD, J. A. *Rev. Canad. Biol.*, 1944, **3**, 251.
3. BRITTON, S. W. and KLINE, R. F. *Amer. J. Physiol.*, 1939, **125**, 730.
4. CLARK, A. J. *Comparative physiology of the heart*. New York: Macmillan, 1927.
5. KLEIBER, M. *Physiol. Rev.*, 1947, **27**, 511.
6. OLIZKI, L. and AVINERY, S. *Brit. J. exp. Path.*, 1937, **18**, 316.
7. ROBBARD, S. *Amer. J. Physiol.*, 1947, **150**, 67.
8. *Ibid.*, **151**, 509.
9. ROBBARD, S. *Science*, 1948, **108**, 413.
10. SUTHERLAND, A. *Proc. zool. Soc. Lond.*, 1899, 787.
11. WETMORE, A. *Smithsonian misc. Collection*, 1921, **72**, 1.
12. WISLOCKI, G. B. *Quart. Rev. Biol.*, 1933, **8**, 385.
13. WOODBURY, R. A. and HAMILTON, W. F. *Amer. J. Physiol.*, 1937, **119**, 663.

On the Amendment of the Nomenclature of the Rh-CDE System

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The recent article by Castle, Wintrobe, and Snyder on the nomenclature of the anti-Rh-CDE typing serums (1) has served to clarify the situation but poorly, and has brought out into the open the confusion that exists in the terminology of the Rh-CDE factor. The Wiener classification (6, 7, 10) using the Rh and Hr terms is unwieldy. Anyone who has tried to learn (and teach) the terminology of Wiener, with the hat, arm, and glove symbols (5), has soon become lost in flights of fantastic conjectures. The steps taken by Race (2), and later elaborated and expanded (3), have pointed a path through the forest of the Wiener complexity.

But the recommendation of the Review Board (1) that both systems be used concurrently has done the field of immunology an unintentional disservice. The Rh-CDE

terminologies are too confusing to exist side by side. Eventually one or the other must achieve universal acceptance. The Fisher-Race terminology (2, 3) is familiar to everyone. There are many reasons why it is easier to teach and learn.

For example, Wiener (9) must use a different set of terms for the genotypes and the phenotypes (R_h , R_h , and R , R , etc.). So the worker in the field must learn another terminology. This is obviated in the British system. $\frac{CDe}{Cde}$ clearly indicates all the information necessary.

Another point is that the symbol R_h does not indicate whether the individual referred to is homozygous or heterozygous (4, 8, 9). The corresponding symbol of Race (3) does, $\frac{CDe}{CDe}$ or $\frac{CDe}{Cde}$. The importance of this can be seen in the following example. In the mating of two individuals—one, R_h , the other, rh —the possible progeny are Rh' , R_h , R_h , and rh . (It reminds one of multiplying with Roman numerals, i.e., $XIV \times VIII = CXII$!) One must memorize the entire table (9); one cannot easily work out the genotypes involved. There are also multiple matings possible, but the Wiener terminology does not take that in consideration. When he feels additional explanation of a phenotype is needed, he mentions it in a footnote (11).

TABLE 1

Wiener		Race		Proposed	
Antigen	Agglutinin	Antigen	Agglutinin	Antigen	Agglutinin
R_h	Anti R_h	D	Anti D	D	Anti d
rh'	Anti rh'	C	Anti C	C	Anti c
rh''	Anti rh''	E	Anti E	E	Anti e
Hr	Anti R_h	d	Anti d	D'	Anti d'
rh'	Anti rh'	c	Anti c	C'	Anti c'
rh''	Anti rh''	e	Anti e	E'	Anti e'

How much simpler is the Fisher-Race nomenclature: The R_h individual is either homozygous $\frac{CDe}{CDe}$ or heterozygous $\frac{CDe}{Cde}$, and in matings with an rh $\frac{Cde}{Cde}$ individual, the results would be (in the first mating) $\frac{CDe}{Cde}$; in the second mating: $\frac{CDe}{Cde}$ or $\frac{Cde}{Cde}$. There is nothing esoteric or far-fetched about it.

But the Fisher-Race nomenclature has still some confusing terms. The use of the lower case letters c, d, and e, to denote the Hr antigens leads to ambiguity when it is remembered that in the major groups, a and b indicate agglutinins. It is therefore proposed that the lower case letters be reserved for agglutinins, leaving the capital letters to indicate antigens.

Table 1 will clarify the proposed change. The advantages are quite obvious. No confusion can exist in either the reading or the speaking of these terms. Allowance is made for the discovery and naming of new antigens and agglutinins. Also their reciprocal relation is retained: D and D'; c and c'.

Conclusion. The great contributions made by Dr. Wiener in the field of immunology cannot be denied. However, although a subject must necessarily be scientifically correct, it must also be as clear and intelligible as possible. The adoption of the Fisher-Race terminology is a step forward, but there is still some confusion. It is hoped that the proposed changes will also lead along the same path to a clearer understanding.

References

1. CASTLE, W. *et al.* *Science*, 1949, **109**, 27.
2. RACE, R. R. *Nature*, Lond., 1944, **153**, 542.
3. ———. *Blood* (Special Issue No. 2), 1948, **1**, 27.
4. WIENER, A. S. *J. lab. clin. Med.*, 1945, **30**, 957.
5. ———. *Amer. J. clin. Path.*, 1946, **16**, 233.
6. *Ibid.*, 1946, **16**, 501.
7. ———. *J. Immunol.*, 1947, **57**, 203.
8. ———. *Paper No. 3*, August 1, 1948.
9. ———. *J. lab. clin. Med.*, 1948, **33**, 985.
10. ———. *Brit. med. J.*, 1946, **1**, 982.
11. WIENER, A. S., UNGER, L. J., and MAZZARINO, C. A. *Amer. J. clin. Path.*, 1949, **19**, 779.

Rate of Elimination of C^{14} Administered as $BaC^{14}O_3$ ¹J. Govaerts^{2, 3}

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A problem of particular importance is the evaluation of the hazard of the long-lived radiocarbon isotope C^{14} . Armstrong and his associates (1) studied the rate of elimination of C^{14} by rats after intraperitoneal injections of sodium carbonate containing C^{14} . The incorporation of C^{14} could be detected in the muscle and liver by implantation of $CaC^{14}O_3$ in the peritoneal cavity and maintaining the isotopic inorganic C^{14} content of the body fluid at a high level over a long period of time. A comparison was also made between the elimination of C^{14} from the tissues by mature and growing rats (3). In general, the rate of excretion of the isotope was very fast. The specific activities of the tissues of growing rats greatly exceeded those of mature animals. The over-all retention of C^{14} , however, was greater in mature rats. In the latter, no significant change in the C^{14} retention was observed from the 15th day after injection, whereas an appreciable decrease in the C^{14} retention was still observed in growing animals. A rapid excretion of C^{14} has been observed by Gould *et al.* (2) after intraperitoneal injection of labeled sodium bicarbonate, acetate, or succinate. After 4 hr the

¹ This research was sponsored by the Atomic Energy Commission.

² While on leave from the Laboratory of Radioactivity and Nuclear Physics, University of Liège, Liège, Belgium.

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cumulative excretion of CO_2 was 95% for bicarbonate, 87% for acetate, and 86% for succinate.

Barium carbonate is the most suitable and common chemical form in which C^{14} is measured, but while handling this material there is a possibility of dusting and consequent inhalation by laboratory workers unless adequate precautions are taken. There is very little information in the literature with respect to the danger that might be encountered by those who work with $\text{BaC}^{14}\text{O}_3$ and the following experiments were performed in order to determine the rate at which C^{14} is eliminated by mice when introduced into the lungs as $\text{BaC}^{14}\text{O}_3$.

In an ideal experiment, mice would be kept in an atmosphere in which a dust of Ba^{14}O_3 was continuously maintained. Under these conditions experimental difficulties would be encountered, particularly the need for a large amount of barium carbonate of high specific activity.

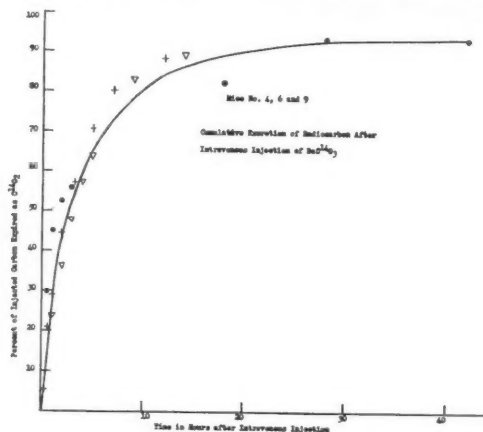


FIG. 1.

For this reason intravenous injections of a fine suspension of $\text{BaC}^{14}\text{O}_3$ in isotonic glucose solution were given in order to deposit the barium carbonate in the lungs of mice. In preliminary experiments, 3–60 min after injection the $\text{BaC}^{14}\text{O}_3$ was rapidly fixed by the lungs and no significant activity was found in soft tissues. As expected, most of the injected suspension of $\text{BaC}^{14}\text{O}_3$ is deposited in the lungs.

Each mouse was placed in a metabolic cage for the duration of the experiment. The cage was swept with a continuous stream of air that was bubbled through a tower filled with NaOH solution in order to fix the expired CO_2 . Before admitting the air to the cage it was made CO_2 -free by passing it through a tower containing moistened soda lime. The expired CO_2 was fractionated, and the urine and feces were collected. The mice were sacrificed by ether, and the thorax was immediately opened. The lungs, kidney, liver, and spleen were removed, dried, and weighed for separate assay. The tissues and excreta were dried in vacuum for two days at room temperature.

The expired CO_2 was precipitated as barium carbonate, which was filtered, dried, and weighed. The excreta and

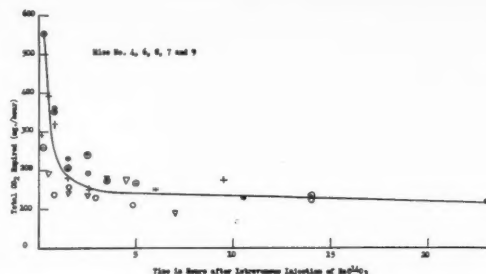


FIG. 2.

internal organs were incinerated according to the Van Slyke-Folch method (4, 5); the CO_2 produced was absorbed and treated in the same manner as expired CO_2 .

Most of the barium carbonate samples were counted as $\text{BaC}^{14}\text{O}_3$ plates, using either a thin mica-window Geiger-Müller tube or a Nucleometer (Radiation Counter Laboratories, Chicago, Illinois), depending on the specific activity of the sample. Some samples of very low specific activity were measured using an ionization chamber with a vibrating reed electrometer. Total radioactivity of each sample was determined, and percentage of activity in the initial dose recovered was calculated. In some cases, the radioactivity of the remaining carcass was determined.

The representative findings concerning the cumulative excretion of C^{14} as CO_2 are represented in Fig. 1. These typical data obtained from three mice indicate that C^{14} appears in the expired CO_2 immediately after injection. The excretion by the lungs of the injected C^{14} is very rapid; about 45% of the injected dose is expired during

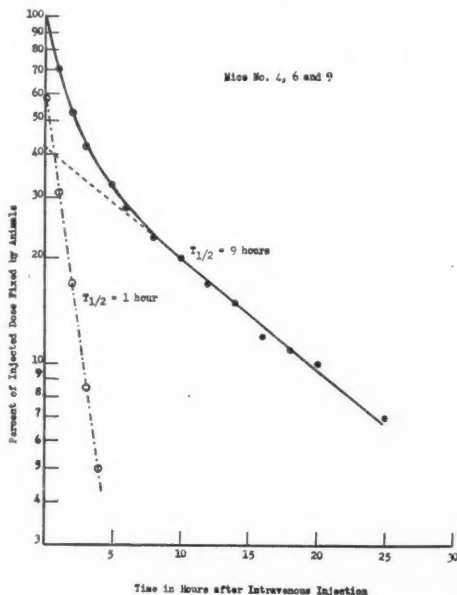


FIG. 3.

the first hour after administration. Later, the excretion is slowed down progressively, and after 12 hr about 85% of the dose is excreted as $C^{14}O_2$. In these animals no significant activity is found in the tissues collected and the same observations have been made for the excreta collected during the experiment. About 88%–99% of the total activity was recovered. Since the amount of residual C^{14} in the body at the time of sacrifice was very small, failure to find measurable amounts of C^{14} in the tissues is not to be interpreted as evidence that none was there.

The injections of barium carbonate produced an increase of the total quantity of CO_2 expired by the mice as shown in Fig. 2. The total CO_2 expired becomes three to five times higher than the normal value, which is reached only several hours after injection.

The half-life of retention by the body can be estimated from a plot of the data on semilogarithmic paper in which the percentages of the injected dose remaining in the animal are plotted on the logarithmic axis and time on the regular axis. As shown in Fig. 3, it is possible

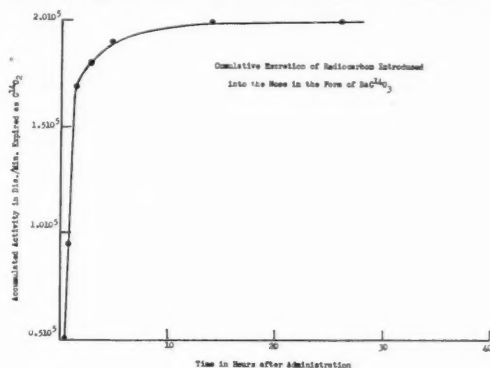


FIG. 4.

to obtain curves analogous to radioactive decay curves. The curves obtained present two processes corresponding to two biological half-lives of 1 hr and 9 hr, respectively. We observe first a rapid excretion of the injected C^{14} , followed by progressively slower excretion. The biological half-lives reported here apply only to the particular experimental conditions described in this paper.

In order to obtain more information about the mechanism of excretion of radiocarbon by the lungs, some experiments were performed by injecting mice intravenously with sodium carbonate containing C^{14} . The curves representing the cumulative excretion of C^{14} in the form of $C^{14}O_2$ are very similar to those obtained with barium carbonate injections. About 70% of the injected dose is excreted during the first 3 hr following administration. After that time, negligible amounts of radiocarbon are expired by the lungs. If the data are plotted on semilogarithmic paper, only one biological half-life of about 1 hr is obtained; most of the C^{14} is expired following a half-life of 1 hr. Comparing these results with those obtained with barium carbonate injections, we find again the rapid excretion by the lungs of C^{14} as $C^{14}O_2$. As with

sodium carbonate injections, no detectable activity could be found in the liver, spleen, lungs, kidney, and excreta. The fact that in these experiments all the radiocarbon was not recovered can be explained by a loss of material during the injections of the small amounts of solutions.

Fig. 4 represents the typical data obtained when C^{14} is introduced into the nose in the form of $BaC^{14}O_3$. The results are expressed as accumulated activity in disintegrations per min expired as CO_2 . Because experimental difficulties were encountered, it is rather difficult to know the exact total dose given to the animal. However, an estimation can be made indicating that up to 70% of the administered dose is excreted within the first 4 hr following administration.

From these data we may conclude that most of the C^{14} absorbed by the organism as barium carbonate is expired by the lungs as $C^{14}O_2$, and that the dangers to those who work with C^{14} are not as great as expected.

References

1. ARMSTRONG, W. D., SCHUBERT, J., and LINDENBAUM, A. *Proc. Soc. exp. Biol. Med.*, 1948, **68**, 233.
2. GOULD, R. et al. *J. biol. Chem.*, 1949, **177**, 295.
3. SCHUBERT, J. and ARMSTRONG, W. D. *J. biol. Chem.*, 1949, **177**, 521.
4. SKIPPER, H. E. et al. *J. biol. Chem.*, 1948, **173**, 371.
5. VAN SLYKE, D. D. and FOLCH, J. *J. biol. Chem.*, 1940, **136**, 509.

Studies on the Metabolism of Administered Cytochrome C by the Aid of Iron-labeled Cytochrome¹

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This journal repeatedly has been the site of discussion of the therapeutic and prophylactic value of cytochrome C injections (3, 6, 8–10, 13). It may, therefore, be of interest to report here some recent findings on the metabolism of administered cytochrome C as traced by the fate of its constituent iron. The production of Fe^{59} -labeled cytochrome C has been reported previously (1). The purity of this preparation based on spectrophotometric analysis and protein dry weight determination was 73%; noncytochrome iron present was less than 2.5% of cytochrome iron. Two male albino rats were injected intravenously with this preparation and exposed immediately thereafter to a simulated altitude of 20,000 ft. Twenty-four hours after injection about 10 ml of blood was drawn by heart puncture, and the animal was decapitated. Cytochrome was isolated from kidney, liver, spleen, and heart, according to Rosenthal and Drabkin (12), and from muscle by a procedure similar to that of Keilin and Hartree (5). A fractionation for ferritin, according to Granick (4), was carried out on portions of the livers and on the kidneys of one of the animals. Fractions obtained and organs were treated according to Peacock

¹ The radioiron used in this investigation was supplied by Carbide and Carbon Chemicals Corporation, Oak Ridge, Tennessee, on allocation from the Isotopes Division, U. S. Atomic Energy Commission.

et al. (7), Vosburgh, or Flexner, and Cowie (14) in the case of larger samples. The results are summarized in Table 1. It seems from the recovery obtained that no major site of radioactivity was missed. The lower recovery in the first rat is due to less complete analysis of fractions and organs.

The distribution of radioactivity suggests that injected cytochrome C is very rapidly disposed of by the body. None of the administered material is found intact with certainty after 24 hr. A large portion is spilled in the urine. It was only in the first 2-hr urine fraction of rat 2 that cytochrome could be found spectrophotometrically. All radioactivity in this fraction, 38.4% of the injected dose, could be accounted for by the cytochrome found. The radioactivity dialyzing from the urine was very little and may be due to cytochrome which passed the dialyzing membrane. The kidney is the principal site of the radioactive material remaining in the body. Although considerable radioactivity appears in the ferritin fraction (5.8%), the bulk is associated with the residue. The disposal of this material may have taken place along pathways indicated by the work of Rather (11) on hemoglobin injections. The small amounts of radioactivity following the isolated cytochrome are very likely due to contamination by breakdown products rather than true admixture of intact radioactive cytochrome.²

Alternate pathways of disposal of the administered material might be pointed out by the fact that rat 1, which did not immediately excrete as much of this material in the urine as rat 2, had considerably more radioiron in liver, liver ferritin, muscle, and bone marrow. The high activity found in muscle and skin is surprising. Although precautions were taken, the possibility of contamination in skin and feces samples could not be excluded. Blood trapped in the organs, however, could not cause a serious error after heart puncture and decapitation.

In addition to the rapid appearance of radioiron in the ferritin fractions, the fact that plasma contained only one-tenth the radioactivity of red cells may be considered the most convincing evidence for the rapid breakdown of injected cytochrome. Assuming 10 mg of hemoglobin iron in rat 2 and an average life of 50 days for rat hemoglobin, 200 μ g of iron is needed for hemoglobin resynthesis in 24 hr. According to the radioactivity found in the red cells, 0.24% thereof has already been made available from the breakdown of injected cytochrome.

Considering the almost complete absence of radioactivity in the cytochrome fractions isolated from the organs, which carry the main part of respiratory metabolism, the complete absence in brain, and the minimal amount found in heart, the beneficial action of cytochrome administration, as repeatedly reported by clinical workers, cannot be due to the known catalytic function of cytochrome in cellular metabolism and hardly to any other property of the intact cytochrome molecule itself, unless a profound species difference would exist.

² Interference from radioactive breakdown products of the injected material is excluded if unlabeled cytochrome is given to rats which have labeled endogenous cytochrome. Experiments of this type gave no evidence of incorporation of the injected cytochrome (2).

TABLE 1
RADIOACTIVITY RECOVERED 24 HOURS AFTER INJECTION OF
Fe-LABELED CYTOCHROME IN MALE RATS

Recovered from	Rat 1 (body wt 322 g, injected with 3.9 mg cytochrome, 6610 cpm \pm 3% *) % of injected dose	Rat 2 (body wt 288 g, injected with 4.6 mg cytochrome, 11476 cpm \pm 3% *) % of injected dose
Kidney, total	36.6	35.2
cytochrome	0.10	0.56
Liver, total	12.1	5.9
cytochrome	0.12	< 0.03
Spleen, total	1.0	0.50
cytochrome	< 0.03	0.03
Heart, total	0.12	0.15
cytochrome	< 0.03	< 0.03
Muscle, total	9.3	4.7
cytochrome	< 0.03	< 0.03
Brain	< 0.03	< 0.02
Lung	0.18	0.14
Gonads	0.19	0.38
Thyroid, adrenals, thymus		0.29
Bone	2.6	1.7
Skin		4.7
Blood, whole	2.6	
red cells		2.4
plasma		0.2
Stomach	0.20	0.17
Stomach content		0.10
Intestines, total	1.51	
small		0.36
large		1.26
Intestine content	0.56	0.40
Abdominal cysts		0.49
Feces	1.8	1.5
Urine	18.4	39.4
Total recovery,† %	87.1	99.9

* Geiger tubes of different efficiency were used in the two analytical series.

† The values are corrected for losses which could be defined. The actual uncorrected recoveries are 80% and 93% for rats 1 and 2, respectively.

References

1. BEINERT, H. and MAIER-LEIBNITZ, H. *Science*, 1948, **108**, 634.
2. BEINERT, H. and REISSMANN, K. R. *Fed. Proc.*, 1949, **8**, 183; *J. biol. Chem.*, 1949, **181**, 367.
3. BENJAMIN, B., STEINER, M., and MILMAN, D. H. *Science*, 1948, **107**, 142.
4. GRANICK, S. *J. biol. Chem.*, 1942, **146**, 451; 1943, **149**, 157.
5. KEILIN, D. and HARTREE, E. F. *Proc. roy. Soc. Lond.*, 1937, **B122**, 298.
6. MILLER, W. N., ANDERSON, P., and DORFMAN, A. *Science*, 1948, **107**, 421.
7. PEACOCK, W. C., et al. *J. clin. Invest.*, 1946, **25**, 605.
8. POTTER, V. R. *Science*, 1947, **106**, 342.
9. PROGER, S. and DEKANEAS, D. *Science*, 1946, **104**, 389.
10. PROGER, S., SCHMIDT, G., and DEKANEAS, D. *Science*, 1947, **106**, 367.
11. RATHER, L. J. *J. exp. Med.*, 1948, **87**, 163.
12. ROSENTHAL, O. and DRABKIN, D. L. *J. biol. Chem.*, 1943, **149**, 437.
13. SCHEINBERG, I. H. and MICHEL, H. O. *Science*, 1947, **105**, 365.
14. VOSBURGH, G. J., FLEXNER, L. B., and COWIE, D. B. *J. biol. Chem.*, 1948, **175**, 391.

A Noncarotene Provitamin A for Fishes

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In the course of other studies on the fat metabolism of marine organisms, a routine ether-acetone fat extraction was made of a mixed zooplankton haul consisting predominantly of the calanoid copepods *Temora turbinata* and *Centropages typicus*. The extract was 1.60% of the wet weight of the organisms. It was deep red in color and highly viscous. The oil was 11.6% nonsaponifiable. When assayed with the Evelyn photoelectric colorimeter with filter No. 440, the mixed carotenoid pigment content was shown to be 1.6 mg/g.

From its color and apparent carotenoid nature it was suspected that this material might prove to be effective as a provitamin A in fishes. It has already been shown by Morton and Creed (5) that carotene is an acceptable precursor for the formation of vitamin A in certain fishes.

TABLE 1
AVERAGE TOTAL LIVER VITAMIN A

Hours after feeding	Control	Plankton oil	Carotene
0	448		
12		308	950
24	208	2140	356
36	80	3825	...

Accordingly, a group of twenty small *Limanda ferruginea*, maintained in three live ears in the open bay, was divided into three experimental groups as follows: the first lot, containing six animals, was unfed except for occasional small organisms that gained access to the live ear between its slats. The second group, six animals, was given a single forced feeding of one gelatin capsule containing 7.5 mg of a mixture of 95% beta- and 5% alpha-carotene dissolved in 0.500 g soya oil. The third set of eight animals each received a single capsule of the zooplankton oil. This contained 0.500 g oil containing a total of 0.800 mg carotene.

The fishes were killed in pairs at intervals of 12 hr after this single feeding. Assays for vitamin A and carotene were run in duplicate on the stomach, the pyloric caecae, the postcecal gut, and on the liver. Assays were conducted by the colorimetric method of the Association of Vitamin Chemists. Carotene was determined in the Evelyn colorimeter with filter No. 440 and a standardization curve.

Results, as they are reflected in the total liver storage of vitamin A, are presented in Table 1. There is a steady, significant increase in total vitamin A content of the livers of those fishes that had been fed plankton oil. The carotene-fed fish show an earlier response. The subsequent marked decrease in liver vitamin A in this group may merely reflect a toxicity which expressed itself more

forcibly at 36 hr when the balance of the carotene-fed fish were found dead. Finally there is to be seen a steady progressive decline in the total reserves of vitamin A in the livers of the unfed control fish. This may possibly indicate the rate of utilization of vitamin A by these fish.

In this experiment, then, the administration of plankton oil is followed by a liver response at least 30 times as large as might have been predicted on the basis of the carotene content of the oil administered.

Numerous recent workers (1, 2, 3, 4, 6, 7) have adduced evidence to show that the locus of conversion of carotene to vitamin A in the mammal is the mucosa of the small intestine. To determine whether the fish might show similar reactions, homologous segments of the intestinal tract of *L. ferruginea* were tested. The cecal segment of the gut was removed from living fish, and homogenized with minimal quantities of buffered fish saline at pH 6.6. The liver of the same animals was similarly treated. The homogenates were then divided as follows: One lot of cecal brei was allowed to incubate with no added precursor; another lot was provided with

TABLE 2
RESULTS OF 24-HR INCUBATIONS

Wt of tissue	Additions	Vitamin A/g
2.310 g C.*	none	390
2.400 g C.	0.100 g P.O.†	640
2.150 g L.‡	none	1685
2.260 g L.	0.100 g P.O.	1560
1.122 g C.	none	1127
1.250 g L.	"	"
1.220 g C.	0.100 g P.O.	1426
0.870 g L.	" " "	"

* C.—ceca.

† P.O.—plankton oil.

‡ L.—liver.

plankton oil (0.417 mg/g) in stable emulsion. One lot of liver was incubated with no precursor, and to the other was added plankton oil emulsion in the amount of 0.442 mg/g. A third series was made up of liver and cecal breis mixed approximately equally. Half of this was incubated with no supplementation, and the other received plankton oil in the amount of 0.478 mg/g of mixture.

Table 2 presents the results of such incubations. The cecal homogenate increased in potency by an average of 63.2% after the addition of the plankton oil. The liver homogenate showed no increase at all, and the increase in potency in the combined liver and cecal incubation was no greater than would have been expected due to the action of the cecal component alone. This evidence suggests that the locus of conversion of precursor to vitamin A in these forms is probably the small intestinal region which bears the pyloric caecae. Suggestive also is the fact that the conversion was effected *in vitro* in the same qualitative manner as *in vivo*.

In an attempt still further to identify the fraction of the plankton oil which was responsible for this provitamin A activity, chromatographic fractionation was employed using a mixture of 3 parts CaCO₃ and 1 part celite as ad-

¹This work was made possible by the generous financial support of the Special Products Division, Borden Company.

sorbent, and petroleum ether as solvent. Both the non-saponifiable fraction and the whole oil were fractionated. In both instances a significant proportion of the material originally put on the column was not retained but appeared in the filtrate. On removal of the solvent this was a yellow oil which darkened and solidified on refrigeration. This fraction constituted 83.25% of the whole oil chromatogram. The same pale yellow filtrate appeared when the nonsaponifiable fraction was chromatographed. In this instance it constituted 76.4% of the total recovery.

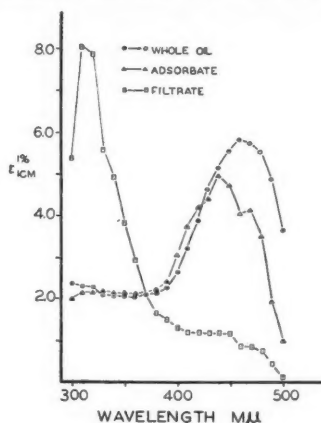


FIG. 1. Absorption spectra of plankton oil and of chromatographic fractions.

Spectrophotometric characteristics of this filtrate, of the combined eluate of the adsorbed pigments, and of the original whole oil are shown in Fig. 1. The adsorbed pigments show typical carotenoid absorption peaks. The primary ingredient of the filtrate material absorbs maximally in the neighborhood of 310 mμ in petroleum ether. There is no evidence of the 325-328 peak characteristic of vitamin A, nor are maxima found in the common carotenoid range.

TABLE 3
EFFECTS OF INCUBATION OF CECAE
WITH PLANKTON OIL FRACTIONS

Time in hr	Filtrate	Adsorbate	Control
0	70 vitamin A/g	78 vitamin A/g	68 vitamin A/g
2	91	60	33
4	121	70	24
5	97	34	22

The biological activity of these two chromatographic fractions was determined by incubating them with homogenates of the pyloric cecae. When added to the cecal brei in amounts proportional to their concentration in whole oil the resulting increase in vitamin A potency is represented in Table 3. It will be seen that all the pro-vitamin A activity resides in the noncarotenoid filtrate fraction of the plankton oil.

Thus it appears that some fishes can utilize zooplankton pigments other than the common carotenoids as raw materials for the elaboration of vitamin A.

References

1. GLOVER, J., GOODWIN, T. W., and MORTON, R. A. *Biochem. J.*, 1948, **43**, 52.
2. GOODWIN, T. W. and GREGORY, R. A. *Biochem. J.*, 1948, **43**, 505.
3. MATTSO, FRED H. *J. Biol. Chem.*, 1948, **176**, 1467.
4. MATTSO, F. H., MEHL, J. W., and DEUEL, H. J. *Arch. Biochem.*, 1947, **14**, 65.
5. MORTON, R. A. and CREED, R. H. *Biochem. J.*, 1939, **33**, 318.
6. THOMPSON, S. Y., GANGULY, J., and KON, S. K. *Brit. J. Nutr.*, 1947, **1**.
7. WIESE, C. F., MEHL, J. W., and DEUEL, H. J. *Arch. Biochem.*, 1947, **14**, 75.

Pantothenic Acid in Copper Deficiency in Rats¹

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According to the work of Free (1), the graying effect in rats could be due either to a lack of vitamins or to a deficiency of copper, and of several other elements. Henderson and his co-workers (3) reported that supplementation of the diet with 100 μg of calcium pantothenate per day had no effect on preventing the graying of piebald rats on a copper-deficient diet composed of whole milk supplemented with iron and manganese, whereas additions of 50 μg of copper sulfate corrected the condition. Other workers have studied the relationship between pantothenic acid and achromotrichia. Unna and Sampson (4) stated that doses of 5, 10, or 20 μg of calcium pantothenate were insufficient to prevent graying, whereas 40 μg gave inconsistent results. György and Poling (2) found that 75-100 μg of pantothenic acid daily caused definite restoration of pigmentation in 5-7 weeks when administered to rats deficient in pantothenic acid.

In our experiment, two groups of piebald and black rats, 22 days old, were placed on simplified diets designed primarily to study a comparison of the weight gains of the animals. In each group there were 15 animals with an average initial weight of 36 g. Group 1 was placed on a basal ration composed of whole dried milk (KLIM) 50.0%, sucrose 49.5%, NaCl 0.49%, manganous sulfate 0.0008%, ferrous sulfate 0.002%, and thiamine hydrochloride 0.00034%. Group 2 was fed the basal ration augmented with sufficient copper sulfate to give an analytical value of 20 ppm copper for the ration. The analytical value of copper obtained for the ration of Group 1 was less than 1 ppm. At the end of a 60-day trial, the two groups showed approximately the same rate of weight gain. The animals of Group 1 at the end of 7 weeks showed a consistent peculiar type of graying identical to

¹ Supported in part by a grant from the Nutrition Foundation, Inc., New York City.

that found in rats deficient in pantothenic acid. The change in the black rats of this group was more striking than in the piebald, although the pattern was the same. There remained a narrow stripe of black hair from the top of the head and extending along the middle of the back to the tail. Graying occurred in the remainder of the black hair. The animals of Group 2 maintained their normal pigmentation, indicating that the basal diet was adequate in pantothenic acid when copper was added. The basal diet had a calculated value of 12.5 μg of pantothenic acid/g of feed.

After maintaining the animals of Group 1 on the basal diet for a total period of 4 months without a fatality, several of the animals were placed on different levels of calcium pantothenate supplement. At the end of 5 weeks of oral administration, the results indicated that a 10- μg daily dose is without effect on repigmentation and a 20- μg daily dose exerts some effect, whereas 30- μg and 40- μg doses cause a pronounced effect, with restoration of most of the normal color. A microdetermination of copper showed that there was less than 1.1 μg of copper in the daily administered dose.

Graying of the hair occurring in black and piebald rats on a copper-deficient ration has thus responded to the administration of either copper or calcium pantothenate. This suggests some metabolic relationship between them, and implies a possible accentuation of pantothenic acid requirements by a deficiency of copper. The absence of any cases of spontaneous recovery in those animals maintained on the copper-deficient ration further emphasizes the importance of copper as a micronutrient concerned with normal hair pigmentation in rats.

References

1. FREE, A. H. *Proc. Soc. exp. biol. Med.*, 1940, **44**, 371.
2. GYÖRGY, PAUL and POLING, C. EDWARD. *Science*, 1940, **92**, 202.
3. HENDERSON, L. M. *et al.* *J. Nutrition*, 1942, **23**, 47.
4. UNNA, K. and SAMPSON, W. L. *Proc. Soc. exp. biol. Med.*, 1940, **45**, 309.

The Isolation of a Mucopolysaccharide from *Aerobacter aerogenes*

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The production of bacterial mucopolysaccharides which are depolymerized by testicular hyaluronidase has been limited to groups A and C streptococci (4, 6). More recently (5) an attempt to utilize polysaccharides from *Bacillus megatherium*, *Leuconostoc dextranicum*, *Rhizobium radicleolum*, and *Azotobacter chroococcum* as substrates for hyaluronidase was unsuccessful.

In the course of our investigations on the ability of bovine testicular hyaluronidase to depolymerize bacterial polysaccharides, a mucopolysaccharide was isolated from a strain of *Aerobacter aerogenes* which was attacked by

hyaluronidase. The present paper is a brief account of these observations.

The strain of *A. aerogenes* gave a mucoid growth on nutrient agar and produced acid from dextrose, sucrose, mannitol, galactose, maltose, and inositol. Large capsules were demonstrable by the moist India ink method (1).

For the isolation of the polysaccharide a medium was used composed of 0.3% beef extract Difco, 1% Wilson SM peptone and 0.5% NaCl. The medium was adjusted to pH 7.4 and sterilized after distribution in 500-ml quantities into Fernbach flasks of 2800-ml capacity. The flasks were heavily seeded with an 18-hr to 24-hr nutrient agar slant culture and incubation was allowed to proceed for 5 days at 37° C. The cultures were centrifuged, and the viscous supernatant liquid was treated with three volumes of acetone. A white, stringy precipitate immediately formed which remained overnight in the icebox.

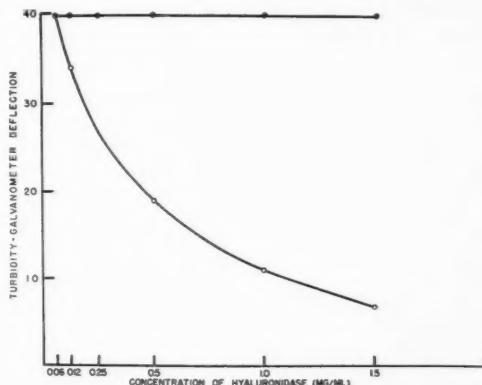


FIG. 1. The depolymerization of *Aerobacter aerogenes* polysaccharide by hyaluronidase. ○ = active enzyme; ● = enzyme inactivated by heat.

The precipitate was separated by centrifugation and the supernatant discarded. The precipitate was further purified by an acetic acid-acetate-alcohol procedure described by Pike (7) for streptococcal hyaluronic acid. A total of three reprecipitations were performed in this manner. The precipitate was next dissolved in distilled water, dialyzed against running tap water for 48 hr, and freeze-dried. The material, a cream-white, amorphous substance, yielded 75 mg to 100 mg per liter of broth.

Solutions of the substance gave negative protein tests with the Biuret, Hopkins Cole, and trichloroacetic acid reagents. Reducing substances were not present as shown by negative Fehling and Benedict tests. A Molisch test for polysaccharide was strongly positive in a dilution of 1:20,000.

The nitrogen content of the polysaccharide as determined by the micro Kjeldahl method was 7.9%; organic phosphate 1.27%; ash 10.5%; sulfur was not detectable.¹

Bovine testicular hyaluronidase prepared by the method of Hahn (2) was used in the depolymerization studies. The enzyme preparation contained 700 turbidity reducing

¹ I am indebted to Mr. Wilhelm Reiss for this data.

units per milligram as determined by the turbidimetric assay procedure of Kass and Seastone (3). A turbidity value of 40 scale divisions on the Klett Summerson photoelectric colorimeter (red filter No. 66) was produced by the interaction of 0.5 mg of polysaccharide and acidified horse serum. The depolymerization of polysaccharide by hyaluronidase was determined by a turbidimetric assay method described in a previous publication (8).

The effect of several dilutions of purified testicular hyaluronidase on the depolymerization of the polysaccharide is shown in Fig. 1. This curve is typical of those obtained with the polysaccharide and is readily reproducible with every batch of material. The heat-inactivated enzyme (60° C for 30 min) does not attack the substrate.

In summary, a polysaccharide has been isolated from a mucoid, capsulated strain of *A. aerogenes* which is attacked by bovine testicular hyaluronidase. The polysaccharide lends itself to purification procedures employed for the preparation of streptococcal hyaluronic acid, but requires much larger amounts of hyaluronidase to accomplish the degree of depolymerization comparable with hyaluronic acid.

References

1. BUTT, E. M., BONYNGE, C. W., and JOYCE, R. L. *J. infect. Dis.*, 1936, **58**, 5.
2. HAHN, L. *Biochem. Z.*, 1943, **315**, 83.
3. KASS, E. H. and SEASTONE, C. V. *J. exp. Med.*, 1944, **79**, 319.
4. KENDALL, F. E., HEIDELBERGER, M., and DAWSON, M. H. *J. biol. Chem.*, 1937, **118**, 61.
5. MADINAVEITIA, J. and STACEY, M. *Biochem. J.*, 1944, **38**, 413.
6. SEASTONE, C. V. *J. exp. Med.*, 1939, **70**, 361.
7. PIKE, R. M. *J. infect. Dis.*, 1948, **83**, 1.
8. WARREN, G. H., DURSO, J. G., and LEVIN, N. R. *Endocrinology*, 1948, **43**, 48.

On the Mechanism of Action of Aureomycin¹

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During a series of experiments on the specific inhibition of phosphorylation by dinitrophenol (6), it was observed that low concentrations of aureomycin³ consistently demonstrated similar inhibitory activity. Thus, in six

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³I wish to thank the Lederle Laboratories, Pearl River, New York, for a generous supply of pure aureomycin.

experiments it was found without exception that aureomycin specifically depressed phosphorylation without inhibiting respiration (Fig. 1). In this action, aureomycin resembles dinitrophenol and other substituted phenols (1, 5), as well as Atabrine (6), gramicidin (1), azide, and methylene blue (7). Penicillin, chloromycetin, and sulfadiazine were inactive when tested in a similar fashion.

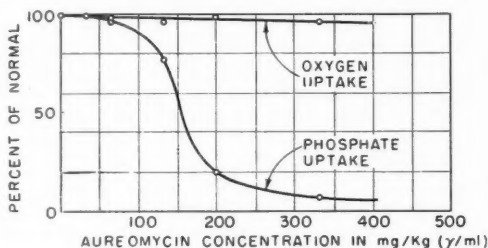


FIG. 1. Specific inhibition of phosphorylation with aureomycin.

Since the test system employed for these studies⁴ is based on the enzymatic activity of normal mitochondria (2, 4, 8), these results suggested that aureomycin in similar concentrations should be toxic to animals. Harned *et al.* (3) studied the acute toxicity of this antibiotic when injected intravenously in mice, and found that concentrations of 130 mg/kg resulted in a mortality rate of 50%, while levels of 170 mg/kg resulted in a mortality rate of 90%.

These results suggest, therefore, that the toxicity of aureomycin is derived from its ability to inhibit aerobic phosphorylation. Whether or not the specific therapeutic activity of this antibiotic is related to these findings cannot of course be determined at present. It is not inconceivable that actively multiplying, invading microorganisms might be differentially susceptible to any lowering of the level of phosphate bond energy beyond that of the mature and undividing host cells.

⁴Details of this method will be described shortly in another journal.

References

1. CROSS, R. J. *et al.* *J. biol. Chem.*, 1949, **177**, 655.
2. GREEN, D. E., LOOMIS, W. F., and AUERBACH, V. H. *J. biol. Chem.*, 1948, **172**, 389.
3. HARNED, B. K. *et al.* *Ann. N. Y. Acad. Sci.*, 1948, **51**, 182.
4. KENNEDY, E. P. and LEHNINGER, A. L. *J. biol. Chem.*, 1948, **172**, 847.
5. KRAHL, M. E. and CLOWES, G. H. A. *J. gen. Physiol.*, 1956, **20**, 173.
6. LOOMIS, W. F. and LIPMANN, F. *J. biol. Chem.*, 1948, **173**, 807.
7. *Ibid.*, 1949, **179**, 503.
8. SCHNEIDER, W. C. and POTTER, V. R. *J. biol. Chem.*, 1949, **177**, 893.

Comments and Communications

Absence of Vitamin A in Liver Oil of the Brown Shark

In determining vitamin A concentrations in the liver oils of some 53 species of aquatic animals, the oils containing the least vitamin A were found to be those from the brown shark (*Apristurus brunneus*) reported here. A male (51 cm) and female (45.5 cm) were taken in Puget Sound on January 21, 1944. The livers were analyzed within a week and found to contain 80 percent and 73 percent oil respectively. The whole oil, when analyzed by the antimony trichloride method, failed to show a measurable amount of Vitamin A. The carcasses, which appeared normal, were discarded before the livers were analyzed; therefore a vitamin A test was not made on the other organs. However, vitamin A, when present in sharks, is usually stored in the liver. The brown shark reaches a length of about 60 cm.

While the occurrence of shark livers without measurable amounts of vitamin A is apparently rare, our observations are not unique. In a study of several hundred soupfin sharks (*Galeorhinus zyopterus*), W. E. Ripley and R. A. Bolomey (*Fish Bulletin No. 64*, State of California Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries) found three instances where livers from immature males contained no vitamin A. They observed the same phenomenon in a number of fetal livers. These findings are in marked contrast to those for most of their other specimens, two of which had livers containing over half a billion international units.

This note, based upon two specimens, is not intended to imply that vitamin A is usually lacking from the liver oil of the brown shark. Rather, it is to point out that the absence of vitamin A in certain specimens raises a question as to its function in the shark's metabolism.

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Radioactive Phenomena at the Hillside Mine

A recent Geiger counter inspection of the Hillside Mine in western Yavapai County, Arizona, showed very high radioactivity throughout the entire mine. Although some areas of commercial grade uranium ore were detected and sampled, there were many places in the mine where no mineralization exists and where no samples could be taken that showed radioactivity when taken away from the mine, but where the background count on the Geiger was ten times normal.

At the shaft station on the 1000-ft level the activity was especially intense, although this station is in country rock. And at close proximity to a high speed, electrically driven ventilation fan at that station the activity was so great that we had to be cautious to prevent damage to the instrument, although our counter is equipped with three

ranges of meter sensitivity. The fan was shut off, but the activity continued and seemed to be centered in dust particles that were adhering to the grid at the air intake of the fan. About two ounces of this dust, when removed, showed radioactivity greater than pure pitchblende. After about an hour the activity of this dust sample had declined over 50 percent and overnight it declined more than 90 percent.

This was a very puzzling situation, as it was not easy to believe that an ordinary electric field could produce radioactive isotopes that gave off gamma rays. (Our Geiger counter is equipped with a shield that cuts out all but gamma radiation, and this shield was in place.)

In studying the matter I came across an article on radioactivity by Sir Ernest Rutherford, the late famous British physicist, which practically hit the nail on the head. He writes as follows (words in brackets are mine):

Radium (which is a product of the disintegration of uranium) is transformed directly into Radon (a gas) which in turn goes through a rapid series of transformations called Radium A, B and C. Radon changes first into Radium A, a substance of period 3 minutes emitting only alpha rays. Radium A changes into Radium B, a product of period 26 minutes emitting beta rays of penetrating power small compared with those emitted from the next period Radium C. The products included under the title Radium C have proved of considerable importance for they not only emit very penetrating alpha and beta rays but are the origin of the gamma rays arising from radium in equilibrium. . . .

When a wire charged negatively has been exposed for some time in the presence of Radon it becomes coated with an invisible film of Radium A, B and C. After removal from incoming Radon for 2 minutes Radium A has practically disappeared and the alpha rays arise entirely from Radium C. . . . Twenty-four hours after removal the activity due to Radium B and C has become exceedingly small. There still remains however a very small residual activity, first noted by Mme. Curie. . . . This active deposit of slow change was examined in detail by Rutherford and by Meyer and Schweidler. It was shown to consist of successive products called Radium D, E and F. Radium D emits slow beta rays and is half transformed in 16 years.

[The subsequent breakdown of Radium F is into lead—a stable end product.]

So this seems to answer the puzzle about the fan dust. The grid at the fan takes on a negative charge and collects the radon or its various short-lived products, which are highly active but disappear in a short time. The large volume of air continually drawn through the fan amplifies the effect.

All this indicates the presence of radon gas in the mine and this would also account for the tremendously high background count in all places in the mine, even where no samples containing uranium could be obtained.

There has been no attempt to measure the amount of radon in the mine atmosphere. The mine has been worked, off and on, for 50 years and no ill effects have been noted.

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Fermentative Capacity of Lactobacilli from Carious Lesions

In W. G. Shafer's paper on the capacity of starch, glucose, and sucrose to produce dental caries in the hamster (*Science*, 1949, 110, 143) it is interesting to note that sucrose was found to be the most caries productive of these three carbohydrates and that there seemed to be a direct relationship between caries productivity and solubility of the substances tested.

If we accept, at least tentatively, the postulation that acidogenic microorganisms play an etiologic role in the dental caries process, it might be highly pertinent to know the fermentative capacities of bacteria associated with and isolated from carious lesions. From unpublished data of a few years ago, it can be stated that lactobacilli found to predominate in the oral cavity of hamsters with dental caries almost all fermented glucose and sucrose equally well, but not starch preparations. Many strains of lactobacilli isolated from the human oral cavity showed similar fermentation reactions, but some strains from non-oral sources definitely showed a preference for the monosaccharide, whereas starch was rarely fermented by any lactobacilli.

Dr. Shafer's results in hamsters are somewhat similar to the findings in rats as observed by Gerald J. Cox and others. Despite the significance of such findings, they apparently cannot be explained on the basis of the biochemical capabilities of some of the bacteria associated with the dental caries process.

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The Agricultural Impasse

Last summer the *Congressional Record*, at the request of Congressman Fred L. Crawford of Michigan, reprinted the first part of W. Gordon Whaley's able article on "The Agricultural Impasse" (*Science*, 1949, 110, 81). Congressman Crawford's remarks on the remainder of this article provide highly pertinent comment on the supposition that agriculture is a "bottleneck" that can be relieved by the biological equivalent of a "Manhattan Project," or "District." It is to be hoped that these remarks, which I quote, may produce, relative to Congress and the government budget, more scientific humility and less political and economic naivete among scientists.

Dr. Whaley . . . then turns to an extensive consideration of Congressional support for plant research in the hope of removing the "impasse" between the "efficiency" of industry and of agriculture.

We should beware, however, of the idea that the land can be made into an "endless frontier" by science; for nature is no nest of safe deposit boxes awaiting the pleasure of Congress in fostering research to unlock their secrets and enable us to draw sustenance for an indefinite expansion of population. It is not possible that "the science of handling the

land and its plants and animals" can afford an "alternative to the age-old unbalance of . . . the haves and have-nots, and the birth of countless millions of human beings to the misery of inadequate food," unless those births are restrained instead of encouraged by social measures.

Except for irrigation, for which the opportunity is nowhere very extensive, man's culture of plants has generally reduced the pristine photosynthetic capacity of the earth's plant cover in order to attain what Dr. Whaley calls "fine goods" that can be eaten. Restoring some measure of this primitive capacity by scientific agriculture is feasible. But to match the harvesting capacity of our modern, mechanical Frankenstein by an equally expansive biological technology is to deal in Brobdingnagian fantasies. "Unraveling the facts of growth, development, and reproduction" can hardly outstrip the work of countless generations of biological evolution by utilizing anything which that evolution has made possible in plant growth. When, if ever, man does succeed in outstripping the productive capacity of vegetable life, he will have to by-pass and displace plant life by himself becoming, in effect, a plant species through the development, not of biological, but of physical, science. Until then the farm will remain, as it now is, just a farm and not a factory.

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Note on the Protective Action of Diparcol against Lethal Doses of Nicotine

C. Heymans and J. J. Estable (*Science*, 1949, 109, 122), reporting on the nicotinolytic activity of N-diethyl-amino-ethyl phenothiazine (diparcol), stated that 15-30 mg/kg of this material, injected intravenously into dogs under chloralose anesthesia, gave complete protection against 100-200 lethal doses of nicotine. More recently, the details of this study have become available (Heymans, C., Estable, J. J., and Castillo de Bonneveaux, S. *Arch. int. Pharmacodyn.*, 1949, 79, 185) and it appears that the statement cited was based on a value of 0.1 mg/kg of nicotine salicylate as the single lethal dose of nicotine.

If this is truly the lethal dose for nicotine under the conditions of the experiment, it would appear that the morphine-chloralose anesthesia used increases the lethal effect of nicotine by 100 to 200 fold. Other investigators have found the lethal dose of nicotine alkaloid to be about 3 mg/kg in unanesthetized dogs (Franke, F. E., and Thomas, J. E. *Proc. Soc. exp. Biol. Med.*, 1932, 29, 1177), about 5 mg/kg in dogs under ether (Thomas, J. E., and Franke, F. E. *J. pharmacol. exp. Therap.*, 1928, 34, 111), and 5 mg/kg in dogs under Dial (Larson, Paul S., Finnegan, J. K., and Haag, H. B. *J. pharmacol. exp. Therap.*, 1949, 95, 506).

Our experience with 30- to 40-mg/kg doses of diparcol (samples kindly furnished by Merck & Co. and Parke, Davis & Co.) in dogs anesthetized with ether or Dial is that it will not protect against the lethal effect of 10 mg/kg of nicotine (2 lethal doses under these conditions).

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J. K. FINNEGAN, and H. B. HAAG

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NEWS and Notes

Arthur Hoyt Uhl will be the new dean of the University of Wisconsin School of Pharmacy when it assumes status independent of the College of Letters and Science on July 1. Dr. Uhl, whose special field of study is pharmaceutical and plant chemistry, has been director of the school for the past eight years.

George Calingaert, associate director of research of the Ethyl Corporation, Detroit, has been appointed professor of chemistry at Hobart and William Smith Colleges, Geneva, New York.

John Z. Bowers has been appointed dean of the University of Utah College of Medicine, effective November 1. Dr. Bowers is at present on assignment at the Crocker Radiation Laboratories in California.

Champion H. Mathewson, professor of metallurgy and chairman of the department at Yale University, will retire June 30, after more than 40 years on the university faculty. Dr. Mathewson was responsible for founding and developing Yale studies in the science of metallurgy and metallography and his own work constitutes an important contribution to basic knowledge in this field.

Philip Handler has been named chairman of the Department of Biochemistry at Duke University School of Medicine. Dr. Handler, who joined the staff in 1939 as associate in physiology, nutrition, and biochemistry, succeeds the late **W. A. Perlzweig**, who died last December.

R. T. Sanderson, associate professor of chemistry at the University of Florida, has been appointed head of the Division of Inorganic and Analytical Chemistry at the State University of Iowa.

Charles O. Gunther, head of the Mathematics Department, Stevens Institute of Technology, since 1908, will retire on September 1. Dr. Gun-

ther, an authority on ballistics, has been at Stevens for 50 years.

Karl P. Schmidt, chief curator of zoology at Chicago Natural History Museum, is spending three months at the University of Frankfurt, Germany, as a member of the University of Chicago faculty exchange team. Dr. Schmidt will be engaged in studies on amphibians and reptiles and will visit leading scientific institutions in Paris and London.

Visitors to U. S.

Sir Claude Frankau, advisor in surgery to Great Britain's health ministry, **Alec A. Martin**, also of the health ministry, **John Smith**, of Scotland's Department of Health, and **Harold Ansley**, director of Canada's health services, were in Washington, D. C. recently to study medical aspects of U. S. home defense plans.

T. S. Toosy, professor of anatomy at King Edward Medical College, Lahore, Pakistan, was a recent visitor at the University of Texas Medical Branch, Galveston, to study methods of instruction in neuroanatomy and tissue culture. Dr. Toosy is making a study of methods of medical teaching to assist in the planning of medical schools for Pakistan.

Pablo Purriel, professor of clinical medicine at the University of Uruguay, and his wife, **Caorsi Purriel**, one of Uruguay's few women physicians, visited the Women's Medical College in Philadelphia last month to study U. S. medical techniques and teaching methods.

Grants

The **John Simon Guggenheim Memorial Foundation** has granted 158 awards this year, totaling \$500,000, the largest number since the foundation was established 25 years ago. Scientists in the U. S. and Canada who received awards are:

Medicine. **F. H. L. Taylor**, director of the Biochemical Laboratory, Boston City Hospital—biochemical approaches to medicine; **Richard W. Lippman**, Cedars of Lebanon Hospital, Los Angeles—renal function and the treatment of renal diseases; **Hans Handforth Zinsser**, School of Medicine,

University of Pennsylvania—theoretical physical chemistry applied to studies of renal dysfunction; **M. C. Terry**, physician, Palo Alto, California—association of taste-blindness and diabetes in the Negro population of Jamaica.

Neurology. **Stephen Polyak**, professor of anatomy, University of Chicago—structure and function of the eyes and their connections with the brain; **Gerhardt von Bonin**, professor of anatomy, University of Illinois College of Medicine, Chicago—construction of an electronic cell counter to assist studies of comparative anatomy of the cerebral cortex.

Biochemistry. **Edward Charles Cantino**, assistant professor of botany and microbiology, University of Pennsylvania—biochemistry of the aquatic fungi; **Ernest Borek**, assistant professor of chemistry, City College of New York—effect of temperature on the utilization of carbon dioxide by microorganisms; **Kenneth Vivian Thimann**, professor of biology, Harvard University—physiology of microorganisms; **Robert Edward Hungate**, professor of bacteriology, Washington State College—nutrition of ruminant animals; **William Eugene Berg**, assistant professor in zoology, University of California, Berkeley—cellular physiology of mollusks.

Chemistry. **Kenneth Sanborn Pitzer**, director, Division of Research, Atomic Energy Commission, Washington, D. C.—chemical applications of quantum and statistical mechanics; **David Milton Soffer**, assistant professor of chemistry, Smith College, Northampton, Massachusetts—chemistry of morphine and related compounds; **William Garfield Dauben**, assistant professor of chemistry, University of California, Berkeley—chemistry of vitamin D; **Evan Charles Horning**, associate professor of chemistry, University of Pennsylvania—organic chemistry as applied to chemotherapeutic problems; **Bryce L. Crawford, Jr.**, professor of physical chemistry, University of Minnesota—statistical mechanics applied to chemical problems; **Robert Arnold Alberty**, assistant professor of physical chemistry, University of Wisconsin—competitive inhibition in enzyme-catalyzed reactions; **Theodore A. Geissman**, professor of chemistry, University of California, Los Angeles—modes of action of physiologically active substances; **Blaine Chase McKusick**, research chemist, E. I. duPont de Nemours & Co.—chemistry of natural products; **Norman Henry Cromwell**, professor of chemistry, University of Nebraska—stereochemistry and ring-cleavage reaction mechanisms of ethylene imines; **Sidney William Benson**, associate professor of chemistry, University of Southern California—chemical kinetics; **Irving Goodman**, assistant professor of chemistry, University of Colorado—nucleic acid derivatives; **Frank Harris Johnson**, associate professor of biology—Princeton University, mecha-

nisms that control biological processes; Frederick Otto Koenig, professor of chemistry, Stanford University—electrochemical thermodynamics; Lester Peter Kuhn, chemist, Ballistics Research Laboratory, Aberdeen Proving Ground, Maryland—organic chemical reactions in sulfuric acid; Paul Mead Doty, assistant professor of chemistry, Harvard University—theory and application of light scattering to colloidal solutions; Kenneth James McCallum, associate professor of chemistry, University of Saskatchewan—microwave spectroscopy.

Geology. Francis John Turner, professor of geology, University of California, Berkeley—orientation of crystals in relation to the structure of marbles and peridotites.

Genetics. Charles Maderia Rick, Jr., associate professor of truck crops, University of California, Davis—cytogenetic studies of wild and cultivated tomato species; Francis Joseph Ryan, associate professor of zoology, Columbia University—mutation in microorganisms; Frank Host Dickey, Merck Research Fellow, California Institute of Technology—mechanism of the formation of antibodies, enzymes, and genes.

Zoology. George Willard Wharton, Jr., associate professor of zoology, Duke University—study of the chiggers of Mexico and their relationships to North American fauna; Herbert Friedmann, curator, Division of Birds, U. S. National Museum—studies of the parasite reproductive habits of the honeyguides and weaverbirds of Africa; Harlow Burgess Mills, chief, Illinois Natural History Survey, Champaign—vertebrate soil fauna; Ray Fred Smith, assistant professor of entomology, University of California, Berkeley—leaf-beetles of the genus *Diabrotica* in the U. S. and Mexico.

Embryology. Samuel Robert Means Reynolds, Department of Embryology, Carnegie Institution of Washington, Baltimore—physiology of fetal circulation.

Botany. Edgar Anderson, professor of genetics, Washington University, St. Louis—origin and development of cultivated plants in the New World; Howard Scott Gentry, research associate in botany, University of Southern California—plant distribution and speciation in the California Gulf region of Mexico; Nicholas Polunin, professor of botany, McGill University, Montreal—arctic botany; Sergius Harry Mamay, botanist, Washington University, St. Louis—Coal Age floras of Europe and America; Wolfram Eberhard, associate professor of sociology, University of California, Berkeley—social structure of southeastern Anatolia.

Psychology. Mary Henle, associate professor of psychology, New School for Social Research, New York City—Influence of needs and attitudes on perception, memory, and other mental processes.

Mathematics. Julian Himely Bigelow, Institute for Advanced Study—logical theory and physical realizability of computational automata; Samuel Ellenberg, professor of mathematics, Columbia University—relations between homotopy theory, homology theory, and algebra; Norman Earl Steenrod, associate professor of mathematics, Princeton University—algebraic topology; Ralph Philip Boas, Jr., executive editor of *Mathematical Reviews*, Cambridge, Massachusetts—theory of entire functions of a complex variable; Philip Hartman, associate professor of mathematics, Johns Hopkins University—singular boundary value problems.

Physics. Sidney Michael Dancoff, professor of physics, University of Illinois—relativistic meson theory of nuclear forces; David Arthur Lind, senior research fellow, California Institute of Technology—precision nuclear gamma ray spectroscopy; Julian Ellis Mack, associate professor of physics, University of Wisconsin—atomic spectra; Michael Kasha, Atomic Energy Commission research fellow in physics, University of Chicago—intermolecular energy transfer; Dave Fultz, assistant professor of meteorology, University of Chicago—large scale motions of planetary atmospheres.

Astronomy. Bart Jan Bok, professor of astronomy and associate director, Harvard Observatory—the Southern Milky Way.

Colleges and Universities

Indiana University Medical School's Physiology Department announces the third course of its George Cyril Graves Lectureship, to be given in the Chemistry Building Auditorium on the Bloomington campus, May 9, 11, and 12 at 4:00 p. m. C. N. H. Long, Sterling Professor of Physiological Chemistry and dean, Yale University School of Medicine, will speak on the role of the anterior pituitary and adrenal glands in the regulation of metabolism. On May 9 his title is "The Metabolic Hormones of the Anterior Pituitary"; May 11, "The Physiology of the Adrenal Cortex"; May 12, "The Regulation of Adrenal Cortical Secretion." All interested persons are invited to attend.

West Virginia University's Tau chapter of Phi Lambda Upsilon is inaugurating an annual chemistry lecture series in honor of Friend E. Clark, professor emeritus of chemistry and former head of the department. The first lectures are to be given at 7:30 p. m. on May 1 and

2, by W. Conrad Fernelius, head of the Department of Chemistry, Pennsylvania State College. His subject will be "Chemical Reactions in Non-aqueous Solvents."

The Enzyme Institute at the University of Wisconsin will have Henry A. Lardy, formerly of the Department of Biochemistry, as head of a second research team beginning July 1. In the early plans for the institute it was decided to have teams of workers, each headed by a leader, rather than an over-all director. The head of the first team is David Green, who started work at Wisconsin in 1947. Both teams will work in the general field of respiratory enzymes.

Summer Programs

Field courses in botany and zoology are being offered by the **West Virginia University Biological Expedition**. E. Meade McNeill, professor of biology and head of the department, Concord College, Athens, West Virginia, will conduct the botany course, and Leland H. Taylor, professor of zoology, West Virginia University, the zoology course. Since enrollment is limited, applicants for either of the courses should make a deposit of \$20 before May 27. Further information may be obtained from Dr. Taylor, Department of Biology, West Virginia University, Morgantown.

A short course on drying oils, sponsored by the American Oil Chemists' Society and the Federation of Paint and Varnish Production Clubs, will be held August 7-11 at the University of Minnesota. Enrollment will be limited to 100. The fee for men in industry is \$25, and for students, \$10. Applications should be sent to Fred E. Berger, University of Minnesota, Minneapolis.

The University of Texas has announced its first **Geography Field School in Latin America**, to be held June 7-August 31 in southwestern Mexico. Emphasis will be placed on the study of land forms, soils, vegetation, fauna, archaeology, settlement patterns, and agriculture. The course is restricted to male citizens of the U. S. or Mexico whose

major subject is anthropology, botany, economics, geology, history, sociology, or zoology. Enrollment will be limited to 18 students and applications will be considered up to May 1. Application forms and further information may be obtained from Donald D. Brand, chairman, Department of Geography, University of Texas, Austin 12.

The Polytechnic Institute of Brooklyn is arranging a series of laboratory courses to be held during June and July. Each course lasts one week and provides for detailed demonstrations and experimentations in its topic. Attendance will be limited to about 12 in order to permit every subscriber to work personally with all the available equipment. The program will be: June 12-23, Industrial Applications of X-Ray Diffraction; June 26-30, Advanced X-Ray Diffraction; and Methods in Physical Biochemistry; July 17-21, Weight and Shape of Polymers in Solution; July 31-August 4, Techniques of Polymerization and Copolymerization.

A detailed program will be sent on request. Further information can be obtained from Prof. I. Fankuchen and Prof. H. Mark, Polytechnic Institute of Brooklyn, Brooklyn 2, New York.

The Armour Research Foundation of the Illinois Institute of Technology has established a **National Registry of Rare Crystallographic Data**, to make crystallographic methods more generally available to researchers. Walter C. Crone, supervisor of the analytical section of the Chemistry and Chemical Engineering Department, will head the registry, which will be conducted as a public service. It will supplement the presently available information on crystallography by survey of current literature and unpublished data now available only in company files. Individuals and organizations may obtain this material by request to the registry, and those submitting data will receive recognition of their contributions.

Industrial Laboratories

The Borden Company's Manufactured Products Division has

named Raymond Powers director of laboratories, to replace Ernest C. Thompson, who has retired after 40 years' service. Mr. Powers joined Borden's Food Development and Engineering Laboratory at Syracuse in 1931, and has been assistant director of laboratories for the past four years.

Ernest H. Volwiler has been elected president and general manager of **Abbott Laboratories**, North Chicago, Illinois. Dr. Volwiler succeeds Raymond E. Horn, who was named president emeritus. George R. Cain was elected executive vice president to succeed Dr. Volwiler. He has been administrative assistant to the president and a member of the executive committee.

Eli Lilly and Company, of Indianapolis, is the first pharmaceutical manufacturer to sponsor basic research in the University of Chicago's Institute of Radiobiology and Biophysics. Firms from the fields of chemicals, food processing, soap making, textiles, oil, tobacco, airplane engine, glass, steel, and electrical manufacturing are already on the sponsor list. The institute is part of the university's \$12,500,000 program to explore the peacetime uses of nuclear energy. It is concerned with the effect of radioactivity on living tissues, and with the use of tracer atoms to uncover basic biological processes in health and disease.

Meetings and Elections

The American Society for Horticultural Science has elected the following officers for 1950: president, S. L. Emsweller, Plant Industry Station, Beltsville, Maryland; vice president, A. F. Yeager, University of New Hampshire; sectional chairman, Stanley Johnston, Michigan State College, S. H. Yarnell, U. S. Vegetable Breeding Laboratory, Charleston, South Carolina, and H. D. Brown, Ohio State University; secretary treasurer, Freeman S. Howlett, Ohio State University; editors and business managers of proceedings, Harold B. Tukey, Michigan State College, and Henry Munger, Cornell University.

The Southern Association of Science and Industry, Inc., will hold its tenth annual meeting in Charleston, South Carolina, May 1. Final balloting for the association's new distinguished service award for the most significant contributions to recent technological progress of the South will take place at the meeting. Two men will be selected annually—one a scientist and the other a business man—to receive the award.

The third annual symposium on orthopedic appliances will be held the week of September 18 in Pittsburgh. The symposium is a cooperative undertaking of the Department of Orthopedic Surgery of the University of Pittsburgh's School of Medicine and Mellon Institute's Multiple Fellowship on Orthopedic Appliances, sponsored by the Sarah Mellon Scaife Foundation. In contrast to the first and second annual symposia, the 1950 session will be devoted to laboratory, shop, and clinic demonstrations and discussions, with active participation by all those in attendance. Inquiries should be addressed to the Orthopedic Appliances Fellowship, Mellon Institute, 4400 Fifth Avenue, Pittsburgh 13, Pennsylvania.

The American Astronomical Society will hold its 83rd meeting at the Kirkwood Observatory in Bloomington, Indiana, June 18-21. This meeting will be part of the 50th anniversary commemoration of the building of the observatory. Members of the society have been invited to participate in the dedication of the Heber D. Curtis memorial telescope of the University of Michigan, at Ann Arbor, June 22-24, following the Bloomington meeting.

The First International Conference of Gerontological Societies will be held in Liège, July 9-12. The conference is sponsored by the Belgian gerontological group, of which L. Brull of the Hôpital Bavière, Liège, is the president. As many as five delegates from each gerontological or geriatrics society will be recognized. The committee representing the American Gerontological Society includes A. J. Carlson, E. V. Cowdry (chairman), R. A.

Moore, A. I. Lansing, and N. A. Shock. All gerontological and geriatrics societies throughout the world are invited to send official representatives and to present papers. Representatives of other organizations engaged in research will also be welcome. In addition to the presentation and discussion of the results of research, it is the purpose of this international conference to establish an international union of gerontological societies and to promote the financing of research in this subject. For information write either to L. Brull or to E. V. Cowdry, Washington University School of Medicine, St. Louis 10, Missouri.

The Third Conference on Reaction Mechanisms in Organic Chemistry will be held at Northwestern University, August 29–September 2. Previous conferences were held at New London, New Hampshire, in 1948, and at Notre Dame, Indiana, in 1946. The program will be as follows: August 29, *Herbert C. Brown*, Chemical Effects of Steric Strains; *Melvin C. Newman*, Some Aspects of Steric Hindrance; and *Peter A. S. Smith*, Acid Catalysis and Azides. August 30, *Christopher K. Ingold*, Aromatic Nitration; *Louis Schmerling*, The Mechanisms of Reactions of Aliphatic and Alicyclic Hydrocarbons; and *O. Beeck*, *J. W. Otvos*, *D. P. Stevenson*, and *C. D. Wagner*, Isomerization of Hydrocarbons over Aluminum Chloride Type Catalysts. August 31, *C. R. Hauser*, Rearrangements, Displacements, and Eliminations Involving Carbanions; *Ralph G. Pearson*, The Role of Carbanions in Some Elementary Reactions; and *Saul Winstein*, Kinetics and Mechanisms of Some Reactions of Organomercurials. September 1, *Avery A. Morton*, General Characteristics of Reactions of Organosodium Compounds; *Robert L. Letsinger*, The Reactions of Organometallic Compounds With Alkyl Halides; and *Cheves Walling*, Structure and Reactivity in Free Radical Reactions. September 2, to be announced.

The general plan of the meeting will follow that of the Gordon Research Conferences, i.e., morning and evening sessions with afternoons

free. In order to retain the conference character of the meeting, attendance will be limited to approximately 150. Accommodations for men and for a limited number of women will be available at Willard Hall and the cost of room and meals will be approximately \$5 per day, in addition to a registration fee, tentatively set at \$2. Applications for attendance should be sent to Cheves Walling, Lever Brothers Co., 164 Broadway, Cambridge 39, Massachusetts, and will be accepted in order of receipt.

Chemical genetics of bacteria will be the subject of a three-week series of lectures and laboratory exercises to be given at the California Institute of Technology by Bernard D. Davis, of the U. S. Public Health Service, starting July 24. The program will include isolation and identification of mutants of *E. coli*, analysis of certain paths of biosynthesis by syntrophism and metabolite substitution, and simple experiments on genetic recombination. The series will be limited to 12 persons. The fee for attending will be \$30 for the three-week period. No academic credit will be given. Inquiries should be addressed to G. W. Beadle, Division of Biology, California Institute of Technology, Pasadena 4.

Two more in the series of *Carus Mathematical Monographs* of the Mathematical Association of America will soon be available through John Wiley and Sons, Inc., New York City. Monograph 9 is "The Theory of Algebraic Numbers," by Harry Pollard of Cornell University; No. 10 is "The Arithmetic Theory of Quadratic Forms," by B. W. Jones, professor of the University of Wisconsin. Each of these publications will cost \$3.00.

A laboratory for scientific investigation of basic health problems in northern areas has been opened in Anchorage, Alaska, by the U. S. Public Health Service. Equipment for research in parasitology, bacteriology, biochemistry, and physiology is included, as well as library

and shop facilities. Research in entomology of Alaskan areas is carried out in another laboratory. Environmental sanitation studies, temporarily located in Anchorage, are being transferred to Fairbanks. Scientists wishing to visit these laboratories should write Dr. Jack C. Haldeman, Medical Officer in Charge, Alaska Health and Sanitation Activities, P. O. Box 960, Anchorage, Alaska.

Make Plans for—

American Association of Colleges of Pharmacy, April 30–May 2, Atlantic City, New Jersey.

Southwestern Division of AAAS, April 30–May 4, Flagstaff and Grand Canyon, Arizona.

American Pharmaceutical Association, April 30–May 5, Atlantic City, New Jersey.

American Society for Clinical Investigation, annual meeting, May 1, Atlantic City, New Jersey.

Symposium on general cytology, May 1–2, Michigan State College, Lansing, Michigan.

American Oil Chemists, spring meeting, May 1–3, Biltmore Hotel, Atlanta, Georgia.

American Geophysical Union and American Meteorological Society, annual meeting, May 1–3, National Academy of Sciences, Washington, D. C.

American Psychiatric Association, annual meeting, May 1–5, Detroit, Michigan.

Association of American Physicians, annual meeting, May 2–3, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

West Virginia Academy of Science, May 5–6, Bethany College, Bethany, West Virginia.

Illinois State Academy of Science, May 5–6, Augustana College, Rock Island, Illinois.

North Dakota Academy of Science, May 5–6, State Agricultural College, Fargo, North Dakota.

Oklahoma Academy of Science, May 5–7, Muskogee, Oklahoma.

General Conference of the Federation Aeronautique Internationale (FAI), May 28–June 4, Stockholm, Sweden.



OUTSTANDING BOOKS IN PSYCHOLOGY

Published 1946-49

*Starred books are WILEY PUBLICATIONS IN PSYCHOLOGY,
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* **PSYCHOLOGICAL STATISTICS**

By QUINN MCNEMAR, Stanford University. 1949. 364 pages. \$4.50.

* **APPLIED EXPERIMENTAL PSYCHOLOGY**

Human Factors in Engineering Design. By ALPHONSE CHAPANIS, WENDELL R. GARNER, and CLIFFORD T. MORGAN; all at The Johns Hopkins University. 1949. 434 pages. 196 illus. \$4.50.

The ORGANIZATION of BEHAVIOR

A Neuropsychological Theory. By D. O. HEBB, McGill University. A WILEY BOOK IN CLINICAL PSYCHOLOGY. 1949. 335 pages. Illus. \$4.00.

* **THEORY of HEARING**

By ERNEST GLEN WEVER, Princeton University. 1949. 484 pages. 138 illus. \$6.00.

PERSONNEL SELECTION

Test and Measurement Techniques. By ROBERT L. THORNDIKE, Columbia University. 1949. 358 pages. \$4.00.

FOUNDATIONS of PSYCHOLOGY

Edited by EDWIN G. BORING, Harvard University, HERBERT S. LANGFELD, Princeton University, and HARRY P. WELD, Cornell University. A WILEY PUBLICATION IN PSYCHOLOGY. 1948. 632 double column pages. 248 illus. \$4.50.

* **METHODS of PSYCHOLOGY**

Edited by T. G. ANDREWS, University of Maryland. With 22 Contributing Authors. 1948. 716 pages. Illus. \$5.00.

* **The PSYCHOLOGY of EGO-INVOLVEMENTS**

By MUZAFAER SHERIF, University of Oklahoma, and HADLEY CANTRIL, Princeton University. 1947. 525 pages. \$6.00.

* **MANUAL of CHILD PSYCHOLOGY**

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FUNDAMENTALS of PHYSICAL CHEMISTRY for PREMEDICAL STUDENTS

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INTRODUCTION to THEORETICAL IGNEOUS PETROLOGY

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An Introduction to Plant Science. By W. W. ROBBINS and T. E. WEIER, *both at the University of California*. Covers the basic facts of plant science and the ways in which they affect agriculture, medicine, and many other fields. The authors emphasize recent discoveries in plant anatomy, photosynthesis, respiration, genetics, water relations, growth substances, chromosome structure, and many other subjects. *April 1950.* 480 pages. 490 illus. \$5.00.

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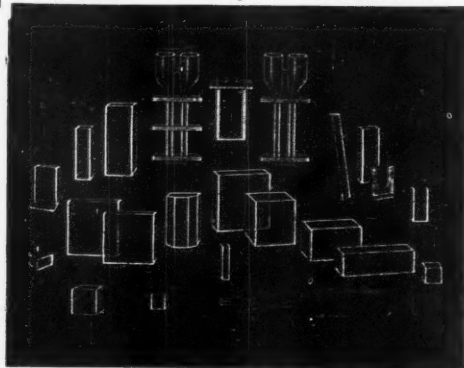
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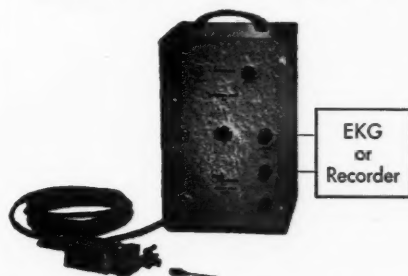
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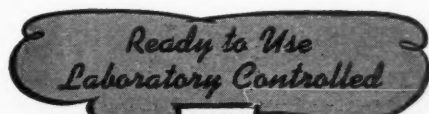
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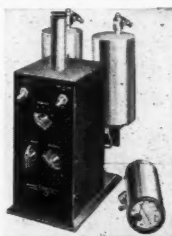
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Bacteriologist: M.Sc., 2 years research, teaching, graduate minor in Organic Chemistry. Box 128, SCIENCE. X

Bacteriologist: Ph.D., June. Biochemistry, Dairy Bacteriology, University Fellow, Sigma Xi, Phi Sigma. Desires industrial fermentation or pharmaceutical research. Box 130, SCIENCE. X

Biochemist: Ph.D. candidate, June, 1950. Experience in clinical biochemistry, amino acids, vitamins, assistant in microbiology. Publications. Sigma Xi. Research position desired. Box 126, SCIENCE. X

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(The Market Place is continued on next page)

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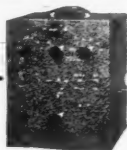
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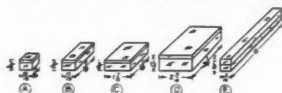
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